

DEVELOPMENT OF A FOUR STAGE CONTINUOUS IMPROVEMENT FRAMEWORK TO SUPPORT BUSINESS PERFORMANCE IN MANUFACTURING SMEs

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Abstract

For over 30 years, authors have documented continuous improvement techniques that can help to improve the performance of the manufacturing sector. However, recent research has found that the uptake of these available techniques for the purpose of improving business performance is comparatively low as a result of barriers preventing their adoption by manufacturing SMEs. The aim and focus of this research is to develop a user-friendly framework which would guide both industry practitioners and other researchers to achieve business process improvements in an SME manufacturing environment.

The framework developed in this study consists of four stages: 1) review of the current process to be improved; 2) identification of possible improvement in terms of prompts; 3) knowledge know-how to support transfer of proven continuous improvement techniques; and 4) continual review of the process to quantify the improvements. The framework uses a combination of three continuous improvement techniques: histograms, brainstorming and Five Whys to identify actions for management implementation. Such techniques have been merged to speed up and simplify the process of root cause analysis, thus encouraging SMEs to document their successes. This will enable other SMEs to learn from their experiences as well as from the knowledge gained by being part of the communities of practice.

The methodology used in this research is mixed methodology and involves a combination of literature review, pilot study, a postal questionnaire with 50 respondents and two case studies. These case studies were then used to validate the framework, based on five structured interviews.

Case studies involving two manufacturing SMEs include manufacturers of high-volume, low-cost components and low-volume, high-cost components. It was concluded that the root cause of a problem can be found by using: brainstorming, histograms and Five Whys. Sometimes, it was also possible to merge these techniques as one, thus reducing the analysis time. The case studies generated substantial savings, £27,500 and £1,366,055 for SME 1 and 2 respectively. Overall the benefits of the framework to SMEs include: using the developed user-friendly framework for improved business performance, knowledge transfer of learning continuous improvement techniques, learning about other SME successes and potential cost savings that could accrue for SMEs when they apply it.

The framework developed in this research, therefore, has reduced some of the barriers which have prevented uptake of innovative techniques over the last 30 years.

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I am very proud to have met a range of researchers at international conferences that I attended and where I have had papers published.

My journal paper was extremely personally rewarding, and involved me being provided with the opportunity to inform other authors of the research that I have been working on during the last few years.

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Publication List

Journal Paper

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Conference Papers

Oduoza, C.F., Barber, K.D. and Smith, P.G. (2008) Enterprise Continuous Improvement Techniques – A Perceived Gap. *Flexible Automation and Intelligent Manufacturing, FAIM2008, Skovde, Sweden*, pp 808-814.

Oduoza, C.F., and Smith, P.G. (2012) Development of a Web-based Tool to Sustain Continuous Improvement and Productivity in Manufacturing Small and Medium Size Enterprises (SMEs). *IEEE International Conference on Adaptive Science and Technology, Kumasi, Ghana*, pp 143-148.

Smith, P.G., and Odouza, C.F. (2014) Analysis of Internet Process Tool for Continuous Improvement and Productivity in a Manufacturing Environment. *Flexible Automation and Intelligent Manufacturing, FAIM2014, San Antonio, Texas, USA*, pp 1093-1098.

Smith, P.G., Odouza, C.F., and Barber, K.D. (2010) Continuous Improvement Tools to Improve Productivity in Manufacturing SMEs. *Flexible Automation and Intelligent Manufacturing, FAIM2010, Oakland, California, USA*, pp 89-96.

Smith, P.G., Odouza, C.F., and Barber, K.D. (2009) Manufacturing Process Improvement: Perceived Barriers from Adoption of Good Practice by SMEs. *Flexible Automation and Intelligent Manufacturing, FAIM2009, Teesside, UK*, 1257-1268.

Abbreviations

AR	Action research
BOM	Bill of materials
BPR	Business process re-engineering
BSI	British Standards Institute
CI	Continuous improvement
COP	Communities of practice
FMEA	Failure modes effects analysis
KDD	Knowledge discovery in accident database
IQS	Integrated quality system
IS	Information system
IT	Information technology
KM	Knowledge management
KMS	Knowledge management system
KPI	Key performance indicators
KS	Knowledge sharing
OEM	Original equipment manufacturer
PDCA	Plan-Do-Check-Act
QC	Quality control
QFD	Quality function deployment
QMS	Quality management system
SECI	Socialisation, externalisation, combination and internalisation process
SCK	Short cycle kaizen
SMEs	Small and medium sized enterprises
SMMT	Society of Motor Manufacturers and Traders
SPC	Statistical process control
SSM	Soft systems methodology
ST	Systems thinking
TPM	Total predictive maintenance
TPS	Toyota production system
TQC	Total quality control
TQM	Total quality management
TS	Technical specification
UK	United Kingdom

US United States

VA/VE Value analysis/value engineering

VSM Value stream mapping

Chapter 1: Introduction to the Research Project

1.1 Introduction

Chapter 1 introduces an overview of the research project, informing the reader of the background, the problem statement and the research questions to be answered. The aim of this research is to develop a framework to support continuous improvement in SMEs. This research also has defined objectives that have been established in order to achieve the aim. The structure of this thesis is also detailed in this section.

1.2 Research Problem

Jevgeni *et al.* (2015) have stated there are many problems that manufacturing companies face today, such as unreliable production processes, poor product quality, financial losses and delays in production delivery. Companies do not often understand the root causes of these problems. Problems in manufacturing can stem from various causes in a range of business areas. In order to survive in the competitive market, companies should always be able to satisfy their customers by continuously improving.

Jonsdottir *et al.* (2014) have noted that globalisation, new technology and competition make today's surroundings ever-changing for organisations. Customers' needs and wants change rapidly, making customer and market share retention an uphill battle. It is important that there is continuous improvement of and a systematic approach to projects.

Zeng *et al.* (2015) have stated that in an increasingly competitive marketplace, both quality and innovation play crucial roles in securing a sustainable competitive advantage.

Cayer (2001) has stated that organisations have failed in the past by choosing the incorrect type of improvement tools to address their problems. Choosing the incorrect type of improvement tool can increase problems even further and still not prevent them.

Meanwhile, Bateman and David (2002) have noted that companies can have initial short-term success with available process improvement tools; however these are not sustainable. Process improvement programmes are useful projects for improving competitiveness, but the concern about maintaining them is well founded.

Ljungstrom (2005) found that many companies struggle with their competitiveness in the market place. The global market has reduced the number of mergers and produced many large companies working at an international level. These companies strive to produce the best product at the lowest cost. The following obstacles are often encountered: the company is totally production-focused and does not support continuous improvement or cross-functional thinking; the ability to learn and create a learning organisation is missing; no response is given to suggestions or improvement ideas; no management commitment; lack of resources; negative opinions on business improvement; culture of people not wanting to implement change; political issues in terms of managers trying to influence purely for their own gains and not necessarily in the best interests of the business.

Khan *et al.* (2008) have stated that SMEs regard frameworks such as the European Foundation for Quality Management (EFQM) as daunting and difficult. What SMEs require is an SME-specific framework that leads them down the continuous improvement journey at their own pace. Typical issues that SMEs can encounter in an attempt to make improvements are: cash-flow problems, customer dissatisfaction, poor deliveries, high volume of work-in-progress, lack of process improvement, high levels of stock, quality internal and customer defects, and lack of flexibility (Khan *et al.* 2008).

Khan *et al.* (2008) have also pointed out that companies that have no desire to improve do not gain from the many benefits that can easily be gained from a process improvement programme. Examples of potential benefits that would not

be gained include: improved customer focus and support; improved delivery performance; improved speed and flexibility; quick and simple changeovers; improved quality performance; reduced rework; good quality-related feedback from customers; reduced WIP; efficient supply chain; increased business performance; and reduced overheads.

SMEs face challenges, and it is important that they understand the problems in order to seek improvements to prevent the problems from reoccurring.

1.3 SMEs – The Challenges They Face

Lewis and Cassells (2010) have documented the specific issues that SMEs face: inconsistent management, lack of time and financial restraints. Hyland *et al.* (1999) have noted that SMEs often have no strategies, or sometimes poorly developed strategies. This can cause business problems, particularly with preventing people within the business from gaining knowledge of a learning process. An important concept for SMEs is the concept of a continuous improvement framework, where employees can learn and benefit from such knowledge.

Sutton (2015) found that customers from around the globe are beginning to respect SMEs. Organisations that strive to be more 'human' in their approach can exceed customer expectations. However, increasing competition and the ever-demanding needs of customers, as well as recessionary and globalisation pressures, emphasise a need to focus on business improvement. In many cases, processes within service industry SMEs are not very well controlled, due to difficult-to-control factors. Events and decisions are made without the adequate skills and experience being present. The survey carried out by Sutton (2015) found that only 57% of SMEs claimed to have made use of improvement tools and techniques, while other SMEs had not implemented any tools or techniques.

Matthee and Heymans (2013) have found that SMEs are considered to be important drivers of economic growth and development throughout the world.

However, to deliver true economic benefits, they need to grow into sustainable and profitable businesses. Expanding into foreign markets provides an excellent vehicle for growth, but many hurdles stand in the way of SMEs making the transition from the local to the international. The difficulty associated with obtaining finance for export market development is a key stumbling block. Matthee and Heymans (2013) comment that financial institutions regard SMEs as high risk, because they have limited resources and capacity and are more likely to default than larger businesses. One of the issues is poor performance by SMEs. Poor performance needs to be prevented to ensure that all of the customer's requirements are met; this prevents the cancellation of orders and lost revenue, which result in an inability to continue to repay loans to financial institutions.

Xu (2013) found that SMEs face the following challenges: low profit margins and relatively backward management. This can affect decisions for the financing required for growth of an SME. Also, there has been a lack of trust between SMEs, universities, research institutes and government departments. SMEs could benefit if they were committed to making change happen within their business environments. Xu (2013) also states that if SMEs do not make change happen, then the problems will not get resolved and this will affect their business performance.

1.4 SMEs – The Way Forward

Makedos (2014) has stated, based on a research study of SMEs, that know-how can increase innovation in the production process and can benefit SMEs in term of improved performance. A cluster approach is feasible, whereby SMEs can learn from each other and also from universities to implement improvements. This could improve their overall competitiveness and productivity. However, only 42% of SMEs thought this was important, while 37% thought that the approach of working within a cluster would increase the strength of their business. Both Makedos (2014) and Oduoza *et al.* (2008), who studied another group of SMEs, agree that there are different barriers and that further work is still required in this area.

Tenera and Pinto (2014) have noted that the current economic crisis has increased the demand for profitable solutions that allow organisations to gain competitive advantage. For this reason, more companies search for management methodologies that enable them to improve their products' or services' characteristics, such as perfecting their processes, reducing their costs, improving the profitability of their invested capital, and increasing customer satisfaction.

Oduoza *et al.* (2008) noted how the specific SMEs researched pointed out that they did not have the resources of large organisations to invest in such continuous improvement techniques. It could, therefore, be difficult for them to implement such techniques. They also lacked the expertise to justify such investment to shareholders because they had limited or no knowledge of manufacturing improvement techniques.

A common barrier is management commitment, which Oduoza *et al.* (2008) also identified. If this barrier can be overcome, it may be possible to remove other barriers by the use of an effective process to support manufacturing SMEs to improve. Such support could be in the form of a framework that does not need financial support or external professionals. Boohene and Williams (2012) also assert that management commitment is crucial: management should encourage change and there should be a coalition of supporters for change. Pieterse *et al.* (2012) also support this view that there is a lack of management commitment. Lodgaard *et al.* (2015) find that, even though CI have been known for decades, the failure rate is still high, with the major barrier being the lack of management commitment. Bengat *et al.* (2015) also state that resistance to change can be a result of leadership inaction, sometimes because leaders are afraid of uncertainty. Management needs to be committed and to lead the way for change.

1.5 Research Question

Is there a continuous improvement framework that manufacturing SMEs could implement in their business to improve business performance, that prevents barriers such as low management commitment or financial restraints?

1.6 Aim and Objectives

Aim

To develop a framework to support continuous improvement in manufacturing SMEs in order to increase business performance.

Objectives

The objectives of this research are to:

1. Critically review available continuous improvement techniques that are value adding to SMEs in order to identify the most efficient techniques used.
2. Critically review and identify barriers that prevent SMEs implementing continuous improvement techniques to improve business performance.
3. Analyse and document the role of key performance indicators, knowledge management and quality management system (for example: ISO 9001, Balanced Score Card and Six Sigma) that could support the use of continuous improvement techniques in an SME environment.
4. Develop a conceptual framework which is user friendly and propose appropriate continuous improvement techniques and methods available to SMEs that could support them without intervention from business professionals.
5. Collect and analyse data of SMEs awareness of continuous improvement techniques and the barriers to adopting them. Validate the developed framework in a case study environment focusing on business

performance and thereby encourage continuous improvement uptake by manufacturing SMEs.

1.7 Research Scope

This research is focused on developing a framework that will reduce the barriers in SMEs that have been identified in published papers (Parumasur and Govender 2013; Panagiotakopoulos 2011).

The study also concentrates on the identification of root causes for management decisions to implement change, which are discovered from use of the framework. This will result in business improvements for the SME.

The research will also be limited to SMEs that expressed an interest in participating in case study work. Chapter 7, Research Limitations contains further detail of the scope of this research project.

1.8 Research Motivation

Authors of publications are motivated to help business become more competitive in today's pressurised business environment.

Makedos (2014) has noted that if SMEs want to be competitive, they must absorb all the know-how available to them. Working within a cluster, where they can learn from the experiences of others, can help SMEs to become innovative. Direction is needed for further research on the ways that SMEs can reduce their costs through increasing innovation within the productive process.

Oduoza *et al.* (2008) have researched SMEs operating in today's highly competitive manufacturing environment. Their research into 50 SMEs revealed that SMEs were operating under pressure to minimise waste and to improve business performance. This type of pressure is often applied by directors or shareholders wanting a return on their investment. This is often set against a backdrop of companies wishing to make profits and provide professional services at low cost. Furthermore, the research conducted by Oduoza *et al.*

(2008) also found evidence that SMEs face resource constraints and may not have the necessary range of skills to research and implement CI techniques to support business improvements. Feedback from the survey indicated that the typical SME often cannot afford to 'buy in' professional consultants to support business improvement projects. Similarly to Oduoza *et al.* (2008), some companies reported poor outcomes from having engaged with business professionals. Finally, the research clearly demonstrated that some SMEs were not convinced of the potential benefits from the investment required to employ process improvement consultants.

Since contemporary industrial systems have become highly automated and mechanised, unexpected downtimes due to failures can interrupt the integrity of production plans and cause financial losses. It is therefore important to increase equipment and labour productivity in order to survive and compete in global markets (Erdem *et al.* 2003). One of these systems most significant challenges is to improve productivity without increasing capital spending (Labanowski, 1997).

It has often been said that because what gets measured gets attention, it is critical that measurements are carefully selected. Furthermore, having too many objectives can dilute focus, so it is wise to use measures that are quantifiable (Ellig, 2011).

There are numerous problems that modern society faces when seeking to secure sustainable development. Among the important issues is reducing the use of raw materials and consequently minimising waste and effluents. Therefore, both broader and more specialised themes should be tackled. Although new insights are emerging into this theme-related problem, many of them still deserve further intensive research. Klemes (2010), Lilja (2009), Lu and Yuan (2011) and Selg and Norkus (1992) promote waste reduction of raw material by making more efficient use of them.

Other pressures may come from within businesses as a result of the various problems and inefficiencies that can affect business performance. Some businesses may not even be aware of these problems. SMEs have constrained

resources compared with larger businesses, which can create barriers such as financial restraints and a lack of management commitment (Brice, 1989).

1.9 Resolving Problems and Inefficiencies

Business operators need certain skills to solve problems and permanently remove inefficiencies. This study will refer to those trained in these skills as business professionals. Authors state in their research that improvement programmes are often limited (Erdem *et al.* 2003), and that the success of a business will depend on improving key business processes (Jones, 1994). Productivity can be described as the relationship between inputs and outputs. Efficiency is then concerned with comparing the observed and optimal values of a producer's inputs and outputs (Rouse *et al.*, 2011). Problem solving is an important issue to overcome: information is required in order to overcome problems, and the problem needs to be presented as a series of facts. Providing the problem solver with good information is integral to finding effective solutions (Condell *et al.*, 2010).

Continuous improvement information is available to SMEs (Juran and Gryna, 1985; Brice, 1989; Oakland, 2000; Murdoch, 1979; McQuater *et al.*, 1995; Ho and Fung, 1994). However Oduoza *et al.* (2008), initial enquiries for this study in the Midlands, UK, indicated that due to the nature of SMEs, operators are apparently unaware of where to obtain such information. Universities, colleges and other institutions offer courses in a range of disciplines that address business improvement.

Interest in finding means of sustainable improvement has increased because of the recent recession. Managers all over the world are trying various improvement concepts, with mixed results. One likely reason for this is the commitment to improve an SME. Additional research is required (Waal, 2012).

To support the aim of this research project, it is important to have a structure that progress can then be measured against.

1.10 Thesis Structure

This research project begins with the challenges currently being faced in a busy competitive global market. The publications on these challenges will be reviewed to support an assessment of the problems and reasons why many businesses do not implement what they say. This research will develop a solution that will finally begin to bridge the gap of uptake to help businesses implement CI techniques and reduce business waste. To achieve the aim and objectives of this research, the following structure is used.

Chapter 1 introduces the importance of the research. It explains the pressures that businesses are under to perform and to improve. The aim, objectives, boundaries and availability of current knowledge are discussed.

Chapter 2 contains a comprehensive critical international literature review, to identify what research has been conducted into continuous improvement to show the current level of application and the problems with uptake.

Chapter 3 explains the method of research implemented in this project. The research approach highlights the importance of precise research planning and a well-structured programme employing well-established methods: literature review, postal questionnaires, surveys, interviews and case studies.

Chapter 4 develops the framework based on extensive research into past studies detailed in the literature review chapter. It considers existing process models and the problems encountered by the end users. Most importantly, this chapter identifies what needs to be considered in the development of the framework for it to work effectively for the end user.

Chapter 5 determines if the framework developed in Chapter 4 would actually work in a business environment. Obtaining the views of people in the case study companies with no prior experience enables the identification of improvements for management implementation.

Chapter 6 validates the framework using two case study businesses and also conducts a detailed analysis of each question from the questionnaire used in

the case study to accurately assess the performance of the framework, in order to ensure that the problems of past users will not be encountered again.

Chapter 7 defines any further work required and brings together the conclusions of this research project, which it is hoped will further encourage the uptake of CI techniques to reduce business wastage.

1.11 Summary

Manufacturing SMEs are constantly under extensive business environment pressure, both from shareholders wanting a return on capital invested and from customers demanding a good product at low cost. Manufacturing SMEs are faced with barriers such as lack of management commitment, financial restraints and lack of resources. Manufacturing SMEs need to face the challenge of overcoming such issues in order to remain competitive in a global market. The way forward is for manufacturing SMEs to improve their performance. This research project's aims and objectives have been developed to create a frame to improve business performance in these SMEs. This thesis has been structured to review available literature and then progress through to the validation of a framework that actually works and can improve the business performance for manufacturing SMEs.

Chapter 2: Literature Review

2.1 Introduction

The introduction in Chapter 1 has identified the problems and challenges that many businesses are facing in today's busy and highly competitive business environment. The research aim and objectives have been identified.

Chapter 2 focuses on the following thesis objectives:

- Critically review available continuous improvement techniques that add value to SMEs, in order to identify the most efficient techniques used.
- Critically review and identify barriers that prevent SMEs from implementing continuous improvement techniques to improve business performance.
- Analyse and document the role of key performance indicators, knowledge management, communities of practice and quality management systems (for example: ISO 9001, Balanced Score Card and Six Sigma) that could support the use of continuous improvement techniques in an SME environment.

Figure 2.1 shows a mind map structure for this research project, showing all the aspects that will contribute to ensuring that this thesis achieves the objectives defined in Chapter 1. These aspects will include a review of: available CI techniques as well as barriers that prevent SMEs from implementing CI techniques; available process models; management systems; CI techniques; and methods for linking CI techniques to their use by means of the Knowledge Management, Soft Systems and Communities of Practice approaches.

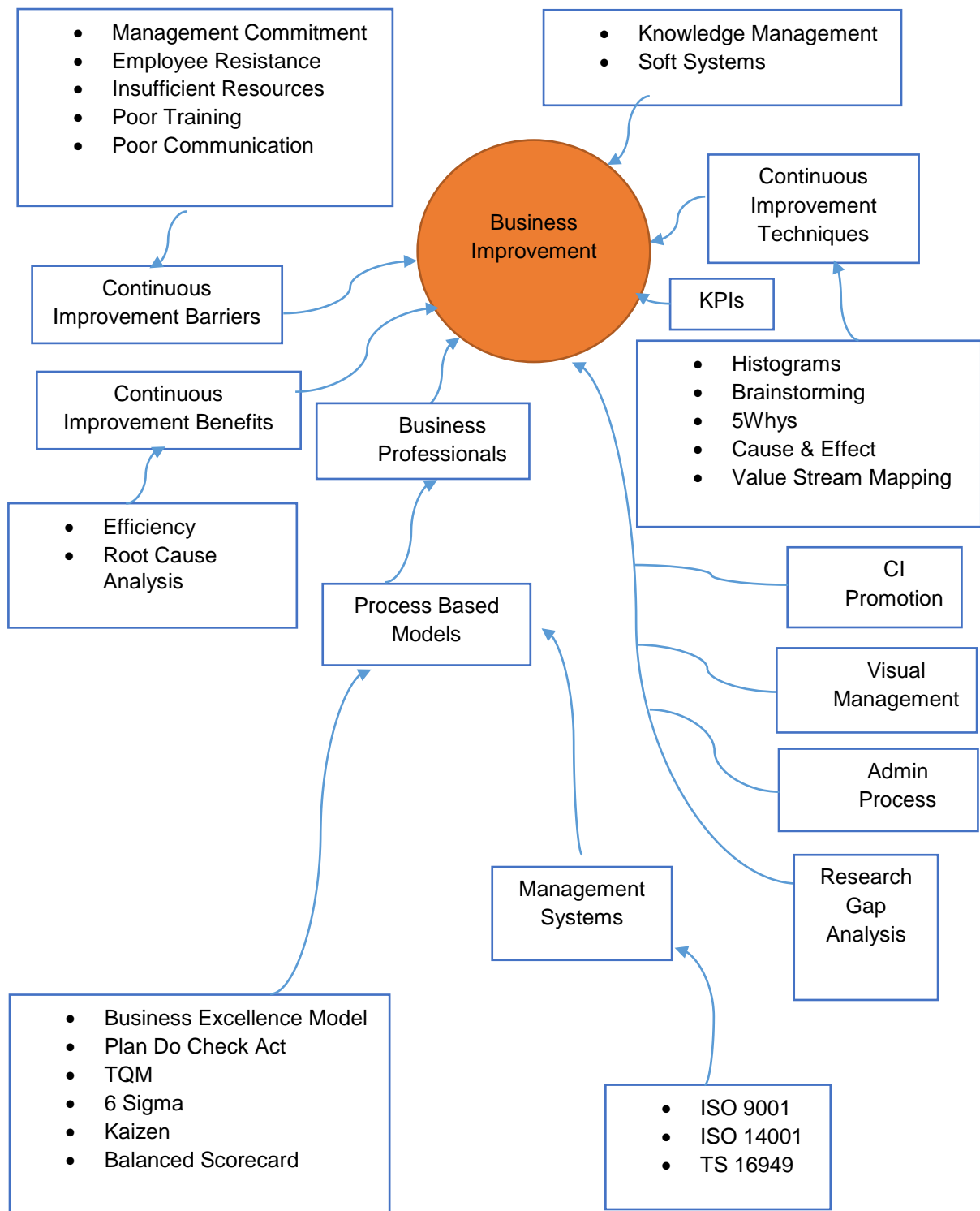


Figure 2.1: Mind map of the literature review

2.2 Operational Definitions

Table 2.1 below shows the operational definitions used in this research project.

Table 2.1: Operational definitions in this research

Descriptive Format	Definition
Framework	A mechanism to link a current business state to an improved business state using available published CI techniques
Continuous improvement techniques	Available published techniques to support SME business improvements
Key Performance Indicator (KPI)	A technique used to plot data
Histogram	A graphical representation of data, often referred to as a CI technique; however, a histogram will not identify a root cause like other CI techniques.
Root Cause Analysis	The use of CI techniques to determine the root cause of a problem
Cause and Effect	Identification of a problem to a within a group: people, methods, material, facilities or environment
Process	Input to an output to add value to a product in a SME manufacturing environment
Management system	A framework to control all activities and processes of a business effectively
Barriers	Problems that SMEs face in preventing improvements
Knowledge management	Knowledge obtained of project successes
Concept framework	A mechanism derived from available knowledge to solve a problem
Soft systems	To consider all the variables in an environment simultaneously to solve a problem
Communities of Practice	Groups learning from others' experiences
Waste	No value-added costs within a SME business environment

2.3 Continuous Improvement Techniques Planned for Use in the Framework

The literature review revealed the following CI techniques, which are considered for use in the framework that will be developed in this thesis.

2.3.1 Histograms

Authors do not state that a histogram is a CI technique, neither do they state that it can identify the root cause of a problem; it is, however, described as a graphical representation of data (Juran and Gryna 1982).

For Juran and Gryna (1982); Cha and Sirhari (200); Arndt (1992); MacQuarter *et al.* (1995) and Cha and Srihari (2002), a histogram is used to show a distribution over a series on counted values. Histograms have a bar for each type of category that has a value. It is important to realise that quantities are actually represented by the area of the histogram. Normally, a histogram should have not less than six and not more than 15 bars. When there are more than 15 bars, they should be grouped. Figure 2.2 shows an example of a histogram with monthly data that have been collected to identify defects.

Juran and Gryna (1982) state that a histogram is easy to use for people who have not used one before and it requires no cost to implement. It requires only time to plan what is to be measured and a commitment to continually recording data. A histogram usefully provides a visual interpretation of data where variation can easily be seen. It also provides an instant graphical representation and helps to make an impact on management so that they will provide support for improvement projects.

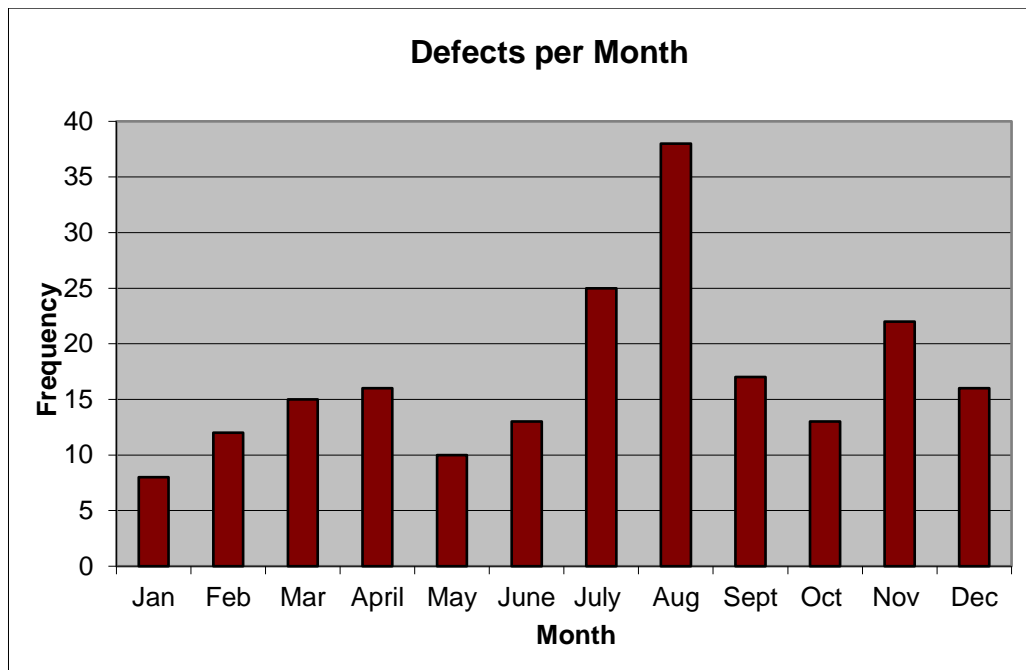


Figure 2.2: Histogram showing defect data collected (Juran and Gryna,1982)

2.3.2 Brainstorming

According to Sealer and Waller (1996), Labanowski (1997); and Oakland (2000), brainstorming is a way of obtaining as much information as possible so that plans and actions are based on the best available knowledge. The rules are designed simply to encourage a contribution from everyone when there is a problem or an opportunity for improvement. Brainstorming is a low cost CI technique that requires some basic training for people who have not used this CI technique before. Brainstorming supports people in developing ideas to find the reasons for the problems encountered on a group basis. This approach saves valuable investigation time when attempting to prevent problems.

The rules are listed below, based on the suggestions of Sealer and Waller (1996), Labanowski (1997); and Oakland (2000).

Organise a session:

- The individual with the problem or opportunity must start the ball rolling.
- Everyone who can contribute should be enrolled or join in.
- There should be agreement on who is the leader.
- There should be support for the leader's attempts to keep the session within these rules.
- Each team member is given a pack of Post-it notes to record each idea/issue they have (one per Post-it note).

Focus strictly on the subject under discussion, having agreed the subject.

Encourage everyone to have their say but try to stick to the facts:

- Do not analyse what is said.
- Keep the ideas flowing
- Do not let prejudice or opinion interfere.
- Respect everybody's experience and expertise.

Feedback to the team:

- Team members to individually provide feedback by describing each of their ideas.
- Team members to place each of their Post-it notes onto either a 'cause and effect diagram' or a flip chart.
- When a cause and effect chart is not used, the activity leader should facilitate grouping the ideas together.

Prioritise the ideas:

- Team members should individually select their first, second and third choice ideas from the final, grouped Post-it notes.
- Team members should individually score five points for the first-choice idea, three points for the second and one point for the third.
- Team members should collectively total the points for each and create a priority list or table showing the highest scoring idea first, the next highest second, etc.

2.3.3 Cause and Effect

According to Juran and Gryna (1982); Arndt (1992); McQuarter *et al.* (1995); Turner (1997) and Stefanovic (2014), the starting point is a list of the possible causes and effects, usually the result of brainstorming a problem. The stages are listed below. The cause and effect approach supports people in a group to identify the solution to a problem by identifying the action that can be taken to prevent the problem from reoccurring again, thereby saving time and money.

First, draw a diagram showing the effect and the main groups of causes. Second, write each item in the list of possible causes under one or more of the headings:

- *People* will include anything affecting individuals, such as training, attitudes, abilities and organisation.
- *Methods* include policies, standards, procedures, instructions, etc., or the lack of them.
- *Materials* include any aspect of product components and consumables, such as specifications and conformance with specification.
- *Facilities* describe the hardware of the workplace, such as tools, jigs, fixtures, equipment, machines and buildings.
- *Environment* is for matters outside the organisation's direct control, such as weather, legislation and market conditions.

Juran and Gryna (1982); Arndt (1992); McQuarter *et al.* (1995); Turner (1997) and Stefanovic (2014) support all of the key points above.

When there are a large number of possible causes in any group, subgroups can be introduced and possible causes written under them. From the list of possible causes, the reason is written on a Post-It note (one per note) as to why a group or subgroup is a source of the problem.

First, the immediate cause is written, then the deeper causes. Sometimes this means re-phrasing the words of the original list. If so, confirmation is received that the re-phrased words are true.

Figure 2.3 shows a cause-and-effect diagram, which focuses attention on the deepest causes that should be the target for improvement action. Although priorities can be allocated using other methods, the greatest benefit will be obtained when all possible causes are eliminated.

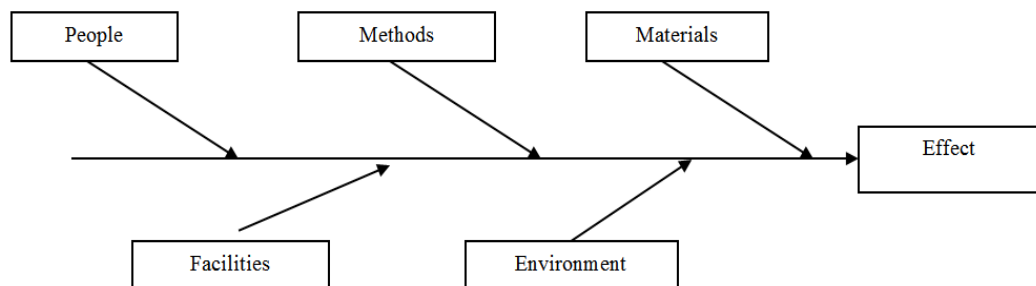


Figure 2.3: Cause-and-effect diagram (Juran and Gryna, 1982)

2.3.4 The Five Whys

According to Benjamin (2009); Imai (1986); Murugaiah *et al.* (2009) and Adams (2008), the 'Five Whys' method can help the development of a clear definition of a problem; it should be used early on in an investigation and should concentrate on the symptoms (effects) rather than on the investigation of the causes. The Five Whys is a low-cost CI technique, which requires only basic training. It is a

direct approach for discovering the true root cause of a problem; it is a quick CI technique to use but will deliver results instantly.

One of the easiest ways to start an investigation is to ask questions that start with the words: What? When? Where? Why? Who? How? and How Many?

As much detail as possible is added to each word. Each word is used in front of as many questions as necessary. Some examples of questions are:

- What is the perceived problem?
- What is the specification?
- What are the measured values?
- What are the customer experiences?
- When does the problem occur?
- When was the problem highlighted?
- Where does the problem occur?
- Why does the problem occur?
- Who reported the problem?
- Who carries out measurements?
- How often do we experience failures?

Benjamin (2009); Imai (1986); Murugaiah *et al.* (2009) and Adams (2008) all support the above bullet points.

The Five Whys concept is that the answers to a series of five 'Why' questions and one 'How' question will lead to more questions. When practicable, the questions and answers are illustrated with sketches. The whole process should build up a comprehensive picture of the problem.

To enable CI techniques to gain management commitment, it is important for CI techniques to have benefits. This information needs to be researched in order to determine the benefits.

2.4 Benefits of Continuous Improvement Techniques

Authors do not quantify savings or specifically state the benefits of each CI technique; however, they do state the benefit that can be obtained from using CI techniques. Arvelo (1995) states that these techniques have been around since the 1950s. Such techniques can bring about incremental improvements for a business to help support them in becoming more efficient and improve business performance. Arndt (1992) points out that these practical techniques can use historical data to solve problems and thereby improve business performance. Chester (1994) researched CI techniques and found that businesses do not just use CI techniques to improve cars and televisions, they can be used to improve any business activity and product. Hall (1993) notes that CI techniques form a systematic method that uses little capital to improve business performance. Labanowski (1997) reported that a fabrication company used CI techniques to deliver a reduction in complexity to manufacturing process reduced cycle time and inventory and increased serviceability. Kram *et al.* (2015) researched a business that had serious problems with deliveries that were caused by various factors using a Kaizen approach, which includes CI techniques on how improvements can be made. Schiele and McCue (2011) promote CI techniques to make improvements in business. For example, they can be used to increase customer satisfaction, add value added savings and improve teamwork. Irajpour *et al.* (2014) also promoted this approach for making improvements.

Businesses that do not implement CI techniques do not achieve the benefits that businesses gain from implementing CI techniques. Arvelo (1995) states that continuous improvement is a technique which identifies value-added and non-value added activities. It improves a business by maximising efficiency. Cayer (2001) notes that choosing the correct type of CI technique can help to solve the jigsaw puzzle; each piece within the puzzle has its appropriate place

somewhere in the overall puzzle. Carpinetti *et al.* (2003) point out that that CI is aimed at continually satisfying customer expectations regarding quality, delivery and service. For Holtskog (2013), continuous improvement is long-term management driven, which, if included in an improvement strategy, can help to sustain competitiveness in global markets. Jonsdottir (2014) has researched businesses that use the CI process to maintain customer requirements and satisfaction. For companies that are interested in CI, this can strengthen their position in regard to customers and competition. It is interesting to note that most CI improvement projects do not require financial investments, but labour and time only.

Barriers that affect the use of CI techniques are now assessed. It is important to understand these so that the issues encountered in the past around not using CI techniques can be prevented.

2.5 Barriers to Continuous Improvement

This section examines the issues that manufacturing SMEs face with regard to barriers when trying to improve their business. For any business to be totally successful, these problems will have to be resolved. The aim of this section is to ensure that the framework being developed in this thesis will not fall victim to such reported barriers.

Table 2.2 shows how publications over the last 30 years have looked at the process of continuous improvement within businesses, identifying barriers of uptake, how knowledge management can help and the identification of business waste.

Table 2.2: Authors who have identified CI techniques, barriers, knowledge management and waste

Reference	Continuous Improvement Techniques	Barriers	KM	Waste
Dwyer and Copland (2007)	Y	Y		Y
Gertsen (2001)	Y			
Hall (1993)	Y			Y
Heard (1997)	Y			Y
Harris (1994)	Y			
Hyland <i>et al.</i> (1999)	Y		Y	
Garcia-Lorenzo (2000)	Y	Y		
McAdam (2000)	Y			
McQuarter <i>et al.</i> (1995)		Y		
Miller and Casavant (1994)	Y			Y
Brooks (1994)		Y		
Lu (2010)		Y		
MacBryde (2012)		Y		
Lilja (2009)				Y
Amar and Zain (2002)	Y	Y		
Beskese and Gebeci (2001)	Y	Y		
Bhat and Rajashekhar (2009)				
Arona (1992)			Y	
Chawla and Joshi (2010)			Y	
Chua (2009)			Y	
De long and Fahey (2000)		Y	Y	
Zhou <i>et al.</i> (2014)			Y	

Bice (1986), who has done research examining continuous improvement methods, informs us that company-wide failure prevention must begin with management controls funding and policy. This is where the first major obstacle occurs because convincing the management to fully commit to a preventive-driven programme requires management understanding, conviction, commitment, discipline, willingness, development, establishment, exercise and investment. The absence of these will create barriers.

Dwyer and Copeland (2007) suggest that one particular major automotive manufacturer supplier is over-reliant on continuous improvement tools and that

it does not fully understand them. Moreover, the company has little idea what continuous improvement really means. Dwyer and Copeland (2007) see much waste being generated within the processes and money being poured down the drain every week. The impression is that many suppliers are frightened to really get to grips with the real meaning of continuous improvement within their business.

Amar and Zain (2002) have identified how a complete lack of management commitment, weak quality management, an inability to change, a lack of accuracy in quality planning, the absence of training and insufficient resources can prevent improvement projects in a business environment.

Bhat and Rajashekhar (2009) have studied barriers to TQM in Indian industries that want to improve. They identified the following barriers: culture and employees, infrastructure, management and organisational issues.

Arvelo's (1995) research on continuous improvement found that it is a technique that helps eliminate non-value added activities; however, this cannot be possible without either management involvement or commitment or without the use of valuable resources.

McQuarter *et al.* (1995) have identified the following pitfalls that can cause difficulties when using quality tools: poorly designed training, being unable to apply what has been learnt, inappropriate use of tools, resistance to using tools, a failure to lead by example, poor measurement and poor communication.

For Gatchallan (1997), the following barriers can halt a TQM project and prevent success: resistance by top management, erratic quality programme implementation, jolting but unsustainable enthusiasm for TQM, inadequate empowerment, poor communication and lack of teamwork.

Harrington (1998) has conducted research into performance improvement within a business environment. He found that the manager's role has to change: the major roadblocks that are put in the way of the employees must be removed before their full potential can be unleashed. Harrington (1998) identifies roadblocks that cause barriers as a lack of employee trust, a lack of delegation, a lack of management credibility, untimely decision making, a lack of training,

misdirected measurement systems, poor communication, a lack of employee loyalty, fear of risk taking and a lack of continuity. The manager must support the process of improvement to avoid such problems.

Kruger (2001) has studied the work conducted by Deming, stating that it is important to drive out fear that many workers have of asking questions of their supervisors even when they do not understand their task properly and do not know what is right from wrong. They need to break down the barriers between staff, most importantly, the barriers that hinder the hourly paid workers.

Oakland and Tanner (2007) have identified some common barriers, which include a constant changing of departments, a lack of communication, resistance to change and little management involvement. In their research, they found that companies that encountered these problems often engage external consultants to do the work for them.

Table 2.3 shows the percentages reported by academics of the most common reasons that cause problems for manufacturing SMEs when they want to improve their business.

Table 2.3: Barriers to SME progress identified by academics by percentage

Barrier	Percentage
Lack of Management Commitment	90
Employee Resistance	50
Insufficient Resources	40
Poor Training	40
Poor Communication	40
Lack of Understanding in CI	35
Poor Teamwork	15
Fear of change	15
Lack of Infrastructure	10
Organisational Issues	10
Poor Planning	10
Weak Quality Management	5
Lack of Quality Planning	5
Lack of Culture	5
Inappropriate Tools Used	5
Inadequate Empowerment	5
Lack of Time for CI	5

CI techniques are used in a business environment to improve the performance of a process within that business; it is, however, important to understand the definition of what a process is.

2.6 The Process – A Definition

A process is the transformation of a set of inputs. These inputs can include materials, actions, methods and operations. The output is the result of the process of converting the input. Processes can be controlled by gathering and using data in the form of a KPI that can be graphically shown by the use of a histogram. Some processes have a high process variation, while others have a

low process variation. A possible framework can link the present state of a process using various CI techniques to make improvement to the process.

Murdoch (1979) has provided a technical understanding of continuous improvement techniques that date back to the 1950s. When continuous improvement techniques are applied, waste is minimised. It is necessary to define, monitor and control the inputs to the process as these can be the outputs of an earlier process. The main objective of the technique is to bring the process under control and prevent waste in terms of not achieving customer specifications (Oakland, 2000).

Continuous improvement techniques have no value in a process until they are used. In order to identify those continuous improvement techniques that may be useful, the applications must first be recognised and understood. Continuous improvement techniques can be used to solve problems in a process. These techniques need to be used by everyone in their normal working environment, not only by highly trained professionals. Straker (1995) highlights that continuous improvement techniques can be used for process improvement and can help to reduce process waste.

This research has been seeking to determine if there is one CI technique that can improve business performance. Therefore, various possible concepts were researched.

2.7 Value Stream Mapping – An Initial Possible Concept for Improvement

VSM is a value-based concept that was initially considered as a basis for the framework; however, it has seen limited published work by academics since 1997, one such work being by Hines and Rich (1997) 'Making use of the seven VSM tools' is the only real paper of any substance in the field of VSM, and even this is viewed by its authors as an ill-defined milestone. This point of view is also supported in a paper by Lasa *et al.* (2008).

VSM is the mapping of inter-company and intra-company value adding processes that can make the final product more valuable to the end consumer. However, the tools identified in Hines and Rich (1997) are viewed as creations of an answer rather than part of the jigsaw. They do not fit well with the requirements of companies.

According to Hines and Rich (1997), the tools used to identify and eliminate waste have been identified by VSM, but they are quite difficult to understand. The systematic attack on waste is also an assault on the factors underlying poor quality and fundamental management problems. Three areas have been identified for review: non-value adding, necessary but non-value adding, and value adding. VSM identifies seven types of waste: overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and defects (Hines and Rich 1997).

The seven tools are presented as Seven Wastes in Table 2.4. In addition, the overall combined value structure will be useful and will also be combined, as shown in the left hand column. In order to make improvements in the supply chain, it is suggested here that at least an outline understanding of the particular wastes to be reduced must be gained before any mapping activity takes place. In the work of Hines and Rich (1997), any of the seven mapping tools are already known although at least two are new, while others will be unfamiliar to a wide range of researchers and practitioners.

Forms of waste are also identified as defined in the Toyota Production System (TPS), a large, mass-production environment that employs professional engineers to reduce waste. This research is involved in SMEs, where often there is also jobbing and small-batch activities, and professional engineers are not employed (Hines and Rich, 1997).

Table2.4: The Seven Stream mapping tools, Hines and Rich (1997)

Waste/Structure	Process activity mapping	Supply chain response matrix	Production variety funnel	Quality filter mapping	Demand amplification mapping	Decision point analysis	Physical structure
Overproduction	L	M		L	M	M	
Waiting	H	H	L		M	M	
Transport	H						
Inappropriate processing	H		M	L		L	
Unnecessary inventory	H	L					
Defects	L			H			
Overall structure	L	L	M	L	H	M	H

Notes: H = High correlation and usefulness, M = Medium correlation and usefulness, L = Low correlation and usefulness.

Hines and Rich (1997) explain the above principles; however, it is quite difficult for those who have not been exposed to, or lack expertise with, VSM to understand these principles and the ways in which they work in the business world. McKellen (2000) explains the principles in a shortened version in contrast to the approach of Hines and Rich (1997) and Lim *et al.* (1999), and Gibbons (2009) supports this approach.

The research by Hines and Rich (1997) aims to remove waste from within companies; however, it does not document an effective framework that could be implemented in an SME to increase business performance. Indeed, by the author's own admission, VSM is ill-defined.

It may be that other improvement techniques are required in order to help SMEs minimise waste. The tools and techniques taken from the Value Stream Mapping approach can support sustainability, particularly when changing from a craft manufacturing to a mass manufacturing process (Vinodh, Arvind and Somanaathan, 2011).

This research now focuses on authors who have promoted the use of CI techniques. This will identify possible benefits and potential CI techniques and also support methods that could help with the development of the framework.

2.8 Literature on Continuous Improvement

This section reviews authors who promote CI techniques that can help support businesses to improve their business. Key elements in the following sub-sections in the process are reviewed to understand more about CI and help the concept development of the framework.

Table 2.5 shows authors over the last 30 years who have promoted commonly available CI techniques that can be applied to support the business improvement: brainstorming, histograms, the five whys, cause and effect, control plans and SPC.

Table 2.5: Authors who promote CI techniques to help businesses improve

Reference	Brainstorming	Histogram	5 Whys	Cause & Effect	Control Charts	SPC
Cha and Sirhari (2002)		Y				
Seaker and Waller (1996)	Y					
Juran and Gryna (1982)		Y		Y		
Adams (2008)			Y			
Arndt (1992)		Y		Y	Y	
Labanowski (1997)	Y			Y		
McQuarter <i>et al.</i> (1995)		Y		Y	Y	
Oakland (2000)	Y	Y		Y	Y	Y
Imai (1986)		Y	Y		Y	
Cha and Srihari (2000)		Y				
Seaker and Waller (1996)		Y				
Stefanovic <i>et al.</i> (2014)				Y		
Turner (1997)				Y		
Murugaiah <i>et al.</i> (2009)			Y			

Continuous improvement is a technique that is frequently promoted to gradually improve a process; however, should all processes be efficient at the design stage of the process, rather than making efforts to continually improve a process over a period that is costing additional time and resources?

The following sections review other aspects that authors promote, which could be used in the development of the framework. First, a review of Kaizen is considered.

2.9 Is Kaizen Supported by CI Techniques?

The more recent emphasis on computerised and automated systems in manufacturing often overshadows the significant inputs from the workforce for improving systems. Continuous improvement stems from Japan, where it is known as Kaizen. It dates from before the Second World War, and it is interesting to note that it came to prominence prior to the works of Deming and Juran. Continuous improvement techniques are used to improve process performance in the form of Kaizen principles by implementing small improvements at a time. This view is supported by Heard (1997) and Arndt (1992). Significant improvements can be made, not only with technological advances but also on the human side, and the author believes that Kaizen and continuous improvement principles can support this. Voelkel and Chapman (2003) also link elements of a team approach in Kaizen and CI that could identify areas for improvement.

When we talk about CI, we are also talking about Kaizen and elements of Six Sigma. Continuous improvement is a collection of techniques that can identify value added and non-value added activities. Such techniques can eliminate waste, maximise efficiency and increase profitability. This can be achieved by involving employees who have a direct impact on the area being analysed (Arvelo, 1995). Lovelle (2001) promotes Kaizen principles in order to go from the current state to the future state, and Arvelo (1995) also supports this approach. It may be that Hines and Rich (1997) failed to identify this approach.

Kaizen relates to finding and eliminating waste in machinery, labour and production methods. Kaizen requires the involvement of everyone in all phases of a company's activities. It is essential for survival and success that this improvement is integral to individuals and companies alike. If people or businesses become 'Kaizeners', this will produce improvements (Lawrence, 1997).

Kaizen, CI and TQM have links with Total Predictive Maintenance (TPM). Having similar approaches with different wording can cause confusion for users and also hinder process-making decisions. The increased sophistication of maintenance personnel has led some companies to replace reactive approaches with newer strategies like TPM. Unexpected downtimes or failures can cause financial losses. Adopting a Kaizen approach towards TPM will result in improvements in equipment effectiveness and reduced lost production time (Erdem *et al.* 2003). This approach is also supported by Farris *et al.* (2009), who reported improvements from the successful adoption of Kaizen practices; however, specialist support is required.

Chester (1994) discusses the interaction of professional support using continuous improvement with a Kaizen approach to help businesses improve, which is also linked to the scientific management approach previously studied by Taylor. This approach requires people with experience and knowledge of the work conducted by Taylor. The objective is to set work standards and quantify times for workers to stick to. Kaizen, on the other hand, is a tool that provides the opportunity for workers to find improved ways of working. Figure 2.4 shows a variety of tools and techniques that are at the disposal of Kaizen practitioners.

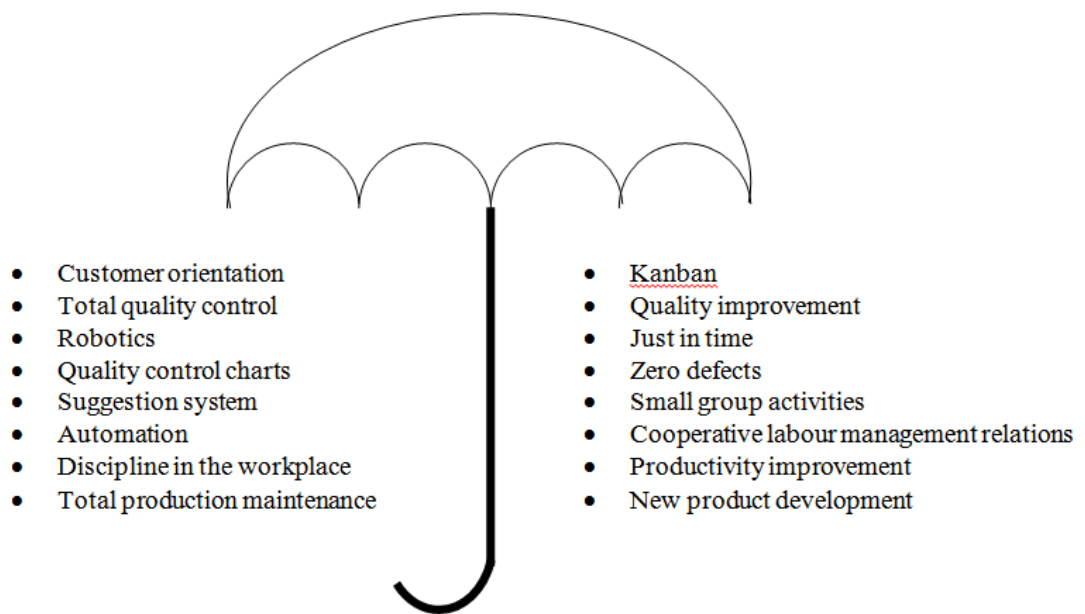


Figure 2.4: The Kaizen Umbrella (Chester, 1994)

According to Gertsen (2001), the purpose of the article is to contribute to a better understanding of these problems by exploring how continuous improvement evolves as a company gains experience. This approach is a reactive one as ideally the processes should really be under control at the process conceptual stage. Gertson (2001) states that the ISO 9001 standard does not use CI as a term or concept. The standard does mention continuous improvement in the concept but does not mention any particular techniques that could help businesses. It may be that the author failed to notice this important point. Gertson (2001) claims that CI is a rather weakly defined concept and tends to be considered a philosophy or an umbrella term. In conclusion, it can be seen that businesses with experience of CI benefit from cost reduction and quality issues. However, it is interesting to note that it is normally larger companies that implement CI.

Heard (1997) notes that, 'continuous improvement is an attractive idea but it is typically more myth than reality'. It may be that Hines and Rich (1997) failed to recognise this in their work involving VSM. The work conducted by this author on Short Cycle Kaizen shows that it is no myth. Rather, it delivers dramatic

improvements using the following: SCK co-ordinator, Kaizen facilitator, workers, specialists, customers and suppliers. A similar approach is documented by McNichols *et al.* (1997). It may be that SMEs could run with this approach without any guidance.

It is important to consider whether Kaizen is more than CI. Chester (1994) certainly thinks so as he considers that Kaizen is about improving the process and not just the product quality. This is a different view to other authors, which could cause confusion when deciding which is the best method to use. Chester (1994) claims that the answer lies not in cultural differences but in an innovative, results-oriented management approach versus process-orientated management.

The Kaizen approach is disciplined, and the only potential downfall for SMEs is that business professionals are required to conduct detailed training. It is interesting to note that Kaizen is about small, incremental improvements. We must consider whether this could be another meaning for CI. Imai (1986) supports this approach, along with including the Seven Wastes from the TPS.

'Continuous improvement is like financial security: everybody wants it but few take the steps necessary to achieve it' (Heard, 1997). This author uses rapid-fire improvement with short-cycle Kaizen. The improvements are required due to competition, rising labour and material costs and higher expectations from customers and stakeholders. The paper seeks to use a condensed form of Kaizen in order to minimise waste and improve efficiency, seeking out the Seven Wastes as defined in the TPS. However, a specialist co-ordinator is required and all workers have to be trained in the requirements of Kaizen. Unlike continuous improvement, Kaizen will deliver improvements to a business. Imai (1986) top management is important to improvement success. The research will now consider this approach.

2.10 Top Management Support

Authors often state that businesses are under pressure to perform. Over the years, it has been suggested that if there was management commitment, this

would reduce the pressure that businesses find themselves in today. Any business that is planning to implement CI must have top management support to ensure that the project succeeds and that any issues are resolved; otherwise, this could cause a barrier to any form of improvement (McQuater *et al.*, 2000). This is also supported by MacBryde *et al.*, (2012), and Brooks, (1994). CI is an approach used by businesses to improve a business and become more efficient whilst creating a team environment. It is comprised of three phases:

1. Top management support
2. Trained participants in the use of CI tools
3. Expanding the philosophy.

The above 3 points are promoted by McQuater *et al.*, (2000)

To prevent problems, time needs to be provided to ensure that the necessary actions are carried out. Continuous improvement techniques identify value added and non-value added activities. Again, top management must be engaged in investing in the funding of failure prevention activities that will minimise future failures and therefore improve profits. They must also support opportunities identified by the workforce (Arvelo, 1995). The business industry is struggling for its very survival and many diverse products are being manufactured abroad quicker, cheaper and with improved quality. The ability to move from failure-driven systems to systems that provide continuous process improvement is important. Management needs to drive this concept and must be involved with the process of CI. They must demonstrate enthusiastic endorsement, commitment, involvement and encouragement. Leadership is required to encourage people in the organisation to work as a team, and these people should be considered as the greatest asset of the business (Paonessa, 2011).

Top management support to ensure success in CI projects is also supported by Jabnoun (2001). Top-down support and also bottom-up support are required to ensure lasting change in an organisation, and it is claimed that this must happen rapidly (Morgan and Avergun, 1997).

Anderson *et al.* (1994), Arndt (1992), Erdem *et al.* (2003) and Szendel and Tighe (1994) do not mention anything that is relevant to top management support. However, other authors, who share similarities in their views with regard to top management, state that it is important for the success of any project (McQuater *et al.*, 2000; Arvelo, 1995; Brice, 1989; Mulhaney *et al.* 2004; Lawrence, 1983, and Oakland, 2000).

To quantify the problems, they need to be measured. Therefore, this research will now consider Key Performance Indicators (KPIs).

2.11 Key Performance Indicators

KPIs can be used for measuring the present state and also for demonstrating improvements in a business. Failure to do this would result in it being very difficult to show any cost impacts that problems are having on a business.

Top management has to want to improve the business. They must support improvement projects and invest where required. They must communicate the profit potential and give profit rewards to employees. If these steps are implemented, improvements are bound to follow (Lawrence, 1983). There must be a commitment from managers showing that they care and want to improve. A systematic quantifiable approach is required in order to gain benefits (Oakland, 2000).

McKie *et al.* (2009) support KPIs to help monitor and improve processes, and the author has had some limited success with an SME. Methods can differ depending upon the type of organisation; however, it is critical that KPIs are quantified and agreed prior to the commencement of a project so that success can be measured. McKie *et al.* (2009) state that KPIs are process measures; therefore, a process-based approach needs to be considered.

2.11.1 A Process-Based Approach

After conducting additional research, it was found that the use of a policy is an effective way of proving top-level commitment. By working to the process model described in both ISO 9001 and TS16949, a reduction in waste will occur (BSI,

2008). However, business professionals are often needed to run and maintain ISO 9001 and TS16949. Figure 2.5 shows a process-based QMS that illustrates the process linkages. Customers play a significant role in defining requirements as inputs. Monitoring of customer satisfaction requires the evaluation of information relating to customer perception as to whether the organisation has met the customer requirements. The figure also shows the methodology of a Plan-Do-Check-Act (PDCA) that can be applied to all processes. This is documented in the ISO 9001 and TS 16949 standard.

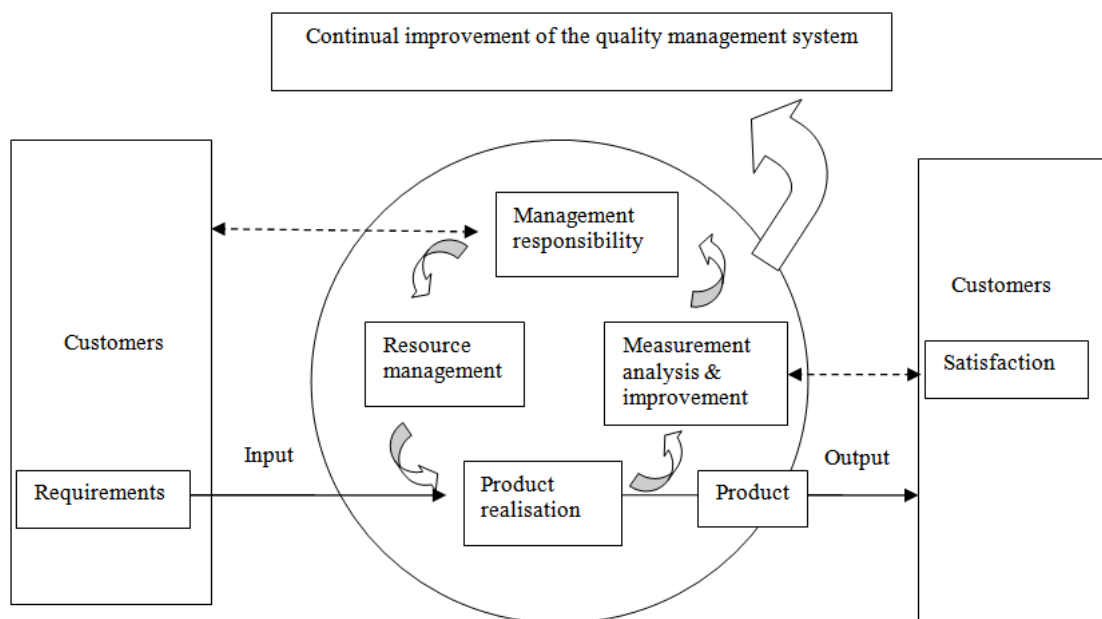


Figure 2.5: Model of a process-based quality management system (BSI, 2008)

Although there are references to large corporations that employ business professionals, the principles may be used for smaller business. It can take up to 30 weeks to develop and implement a result in a loss of interest, and management tend to get impatient if they do not see results. A simplified version may help. There are companies that do not necessarily have the in-house skills to support such projects. If the project is defined in a narrow way, there may be a place for an accelerated CI approach; however, the accelerated

process-based approach may not be for everyone (Harris, 1994). This is also supported by Mulhaney *et al.* (2004).

Literature on training people and involving them in the improvement project is now reviewed.

2.12 Training and Employee Participation

Continuous improvement requires the active participation of all personnel. Twelve SMEs in the automotive industry from the northwest of Spain that supplied Citroen and Peugeot have been focused on. There are three systems: suggestion systems, quality circles and continuous improvement. Internal support is used in the form of group personnel in some cases and, in others, the quality manager or another manager is used to lead the initiative. The problems found were investigated, and it was discovered that some people had not been encouraged to take part. Production, quality, methods and maintenance people were involved, but there was no representation for sales, design, purchasing or accounts. No rewards were given for good ideas, but rather tokens of appreciation were provided, which may not be the best way to motivate people. The SMEs studied in the northwest of Spain did not place great emphasis on the diffusion and appraisal of the results obtained in order to evaluate the contribution of this type of practice to improving competitiveness (Garcia-Lorenzo *et al.* 2000).

McQuarter *et al.* (2000) have found that simple problems demand simple tools. This is often overlooked and forms a barrier to improvement; however, these simple tools can also be used to solve complex problems. The dilemma facing the training manager is to determine the organisation's education and training requirements as opposed to individual education and training requirements. There are large discrepancies in the training levels across industry, and it is apparent from the investigation by this author that there are limitations on the use of more complex techniques. Whether SMEs are capable and committed to training their people to a business professional level is a question that only SMEs themselves can answer. To date, they do not appear able to do this.

McQuarter *et al.* (2000) it may therefore be of benefit to develop a simplified training 'starter pack' to help SMEs to reduce waste and hence improve their performance. However, there is a need to be cautious when there is a lack of experience as system problems can spiral out of control and can cause larger problems. Where this is the case, 'lip-service' can lead to a downward spiral in the concept of improving. If the training manager is not aware of the benefits of CI, how can a skill transfer occur? If problems exist, should training in CI be conducted? The paper does not comment on these two issues.

An article in *Fortune* magazine suggests that the most successful corporations of the 1990s were the 'learning organisations' in which knowledge is widespread, again this is a reactive approach to solve a problem that could have certainly been prevented. Training for effective and continuous quality improvement should be provided to people to ensure that they are competent to conduct their everyday duties. Many organisations in the US are cutting back on training expenditure. Training is an important element of skill transfer, but does it really happen in SMEs? (McQuarter *et al.*, 2000)

The future trend with regard to training looks set to stabilise, which may be encouraging overall, but is it really encouraging to SMEs? Training should be extended to not only existing employees but also to new recruits to ensure that they are competent in their duties. Training should also be extended to CI techniques: do SMEs really implement this approach (Anderson *et al.* 1994)?

There is a choice and it is up to the companies concerned. Persistent education will be required to ensure lasting change. Successfully implementing CI may make a plant successful by funding failure prevention activities, which will minimise future failures and improve profits (Brice, 1989). Training may occur in medium to large businesses; however, to date there is no evidence to suggest that SMEs conduct training in CI techniques (Arvelo, 1995).

Continuous improvement is a systematic method for continually improving the total manufacturing operation with little capital expenditure. It involves all employees in solving problems, eliminating wasteful costs, reducing lead times and improving quality. Absolute minimum resources include: one supplier; no

scrap; no rework; no safety stock; no overproduction; no excess lead times; all labour adding value (Arvelo, 1995).

Employees need to be involved in solving problems; success depends on the people closest to the process. The theory demonstrates positive thinking, although you would think with all of the expertise available, there would not now be problems to still solve following many years of operation. Hall (1993) has reported that Toyota prefers the pull system approach known as Kanban; this concept is shown in Figure 2.6, and this approach ensures that customer requirements are always the focus and that compliance is achieved.

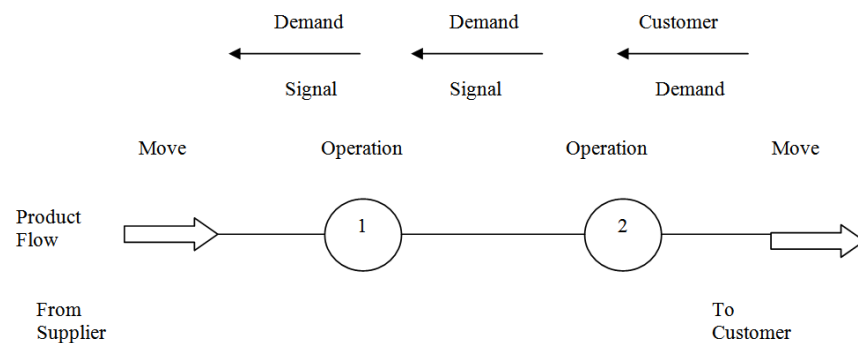


Figure 2.6: Toyota pull system (Hall, 1993)

Successful improvement depends on the employees who are closest to the process. Through training in problem-solving techniques, team members build upon their knowledge and develop their own ideas (Hall, 1993). Miller and Casavant (1994) support the theory that CI requires the focused analysis of data by the trained and empowered people (a quality improvement team) who are closest to the process. By reducing defects, improvements will occur. Defect management can be achieved using the following process: develop a flowchart, collect data, plot data, find the root cause. However, this needs to be supported by the top management.

Reducing rejects will reduce the chance of delivering defects to the customer. This, in turn, will reduce waste. Straker (1995) has stated that an important

factor is the ease with which people can learn to use such techniques. But why are the rejects occurring in the first place? If it is not user friendly, then the particular tool is unlikely to be used. This concept is also supported by Zairi (2000).

There is still no definitive answer as to whether a reduction in training can occur by using an accelerated CI model. Also, if the process is rushed, will more errors occur (Harris, 1994)? Work on accelerated CI projects still requires training that is three to four days long. Projects with a duration of 20 to 30 weeks do not sustain interest and do not normally achieve the proposed benefits. The author suggests that projects work best if they are of a short duration and are focused. However, it is often the case that a business does not have the staff to manage the implementation of an intensive CI project. More research appears to be required on this topic.

Dwyer and Copland (2007) claim that continuous improvement tools do not require much training, but this is dependent on various factors: employee skills, employee motivation, employee competence, level of training and external pressures.

The amount of training required is dependent upon existing employee competence levels, which contradicts the notion that to be competent requires a certain level of training and experience. Dwyer and Copland (2007) have stated that they have seen companies that have much waste within their process, and money is thus being lost. Everyone in the company structure needs to accept change and make improvements work.

Hall (1993) makes reference to industrial engineers and project managers being used in teams. It is often the case that SMEs cannot afford this type of business professional, and therefore another way forward is required. This could possibly take the form of a systematic method to continually improve the process by involving all employees in supporting problem solving, eliminating wasteful costs and improving quality. But how will this knowledge be passed on and by whom?

People are more aware of information technology (IT) and its applications than ever before. They are keen to learn and can manage much more information at once, although this is not always the case in manufacturing SMES. Using data and learning from it can have a direct effect on performance improvement (Vazquez *et al.*, 2012).

It has been discovered from the literature review that different authors place different levels of importance on training, ranging from fully experienced training to basic awareness training. Those authors who mention basic awareness only include Chester (1994), Gertsen (2001) Mulhaney *et al.* (2004), while McQuater *et al.* (2000) claim that training is important and that the training manager should review any issues in order to ensure people are experienced. This is similar to the systematic approach in the form of management systems as defined by the BSI (2008), the TS 16949 (2009), McQuater *et al.* (2000) and Hall (1993). Training builds on knowledge and develops ideas for problem solving (Hall, 1993; Miller, 1994; Lu and Betts, 2010, and Straker, 1995).

Anderson *et al.* (1994) state in an article in *Fortune* magazine that the most successful corporations of the 1990s were learning organisations, and there is no reason why other authors do not make reference to this. Dwyer and Copland (2007) claim that CI tools do not require much training, but there is no definition of how much is 'much', although he does later state that the amount of training depends on existing competence levels.

Management systems are implemented by many businesses. Their application will now be reviewed in this research project.

2.12.1 Management Systems

There is evidence to suggest that systems in the form of a QMS can help to reduce business waste. Over the years, there has been an evolution of a QMS that has been developed by institutions and industry to help businesses to improve. Technical committees in the form of ISO on an international basis have long been established to improve industry. Governments have opted in to promote such systems and have created regulatory bodies in the UK the United Kingdom Accreditation Service to control certification. McQuater *et al.* (2000)

state that ISO 9001 can be used as a framework to support total quality in an organisation. Two popular QMSs are ISO 9001 (BSI, 2008) and TS 16949, (BSI, 2009). QS 9000 is an automotive system that helps to minimise waste; however, there are still issues: registration with QS 9000 does not guarantee consistency. Issues can occur with communication, supervision buy-in and management leadership (Johnson, 2001).

Another system that supports waste minimisation is ISO 14001, Environmental Management System (2004) (see Appendix 1g). The one drawback with such systems as ISO 9001 (see Appendix 1f), TS 16949 and ISO 14001 is that they again require specialist support from business professionals. Management systems promote prevention actions; however, many organisations waste as much as 25% of their time finding and fixing errors because they do not produce conforming output first time round. There are three key reasons why a process may not produce conforming output:

- The output requirements are not understood, defined and agreed
- The process is not capable of meeting the requirements
- The process is not being controlled to ensure it produces only conforming output

If the above fails, there is something seriously wrong, and corrective action must be implemented immediately, with the objective being to prevent the error from occurring again (Munro-Faure *et al.*, 1993).

It is important to remember that:

- Corrective action is used to rectify a product in order to conform to a customer's specification
- Prevention action is to prevent the problem occurring again

It appears that some authors may misunderstand this concept (Munro-Faure *et al.*, 1993).

All management systems have one thing in common: continuous improvement for the business in which it is being used. However, they do not document the type of techniques that could be used to reduce waste. There are some elements of Six Sigma that could be used by businesses in the form of improvement techniques. These are similar elements to the ones that have been documented in the finding of CI (Stamatis, 2004).

Mulhaney *et al.* (2004) also support the view that ISO 9001 can help drive CI through businesses. They concentrate on SMEs, where they use ISO 9001 to drive CI within a SME based in the northwest of England. They talk about awards that are difficult for SMEs to achieve, and they acknowledge that they also have a lack of resources that becomes a barrier to implementing ISO 9001. Figure 2.7 shows a general model adopted, which is loosely based on the Deming Plan-Do-Check-Act cycle.

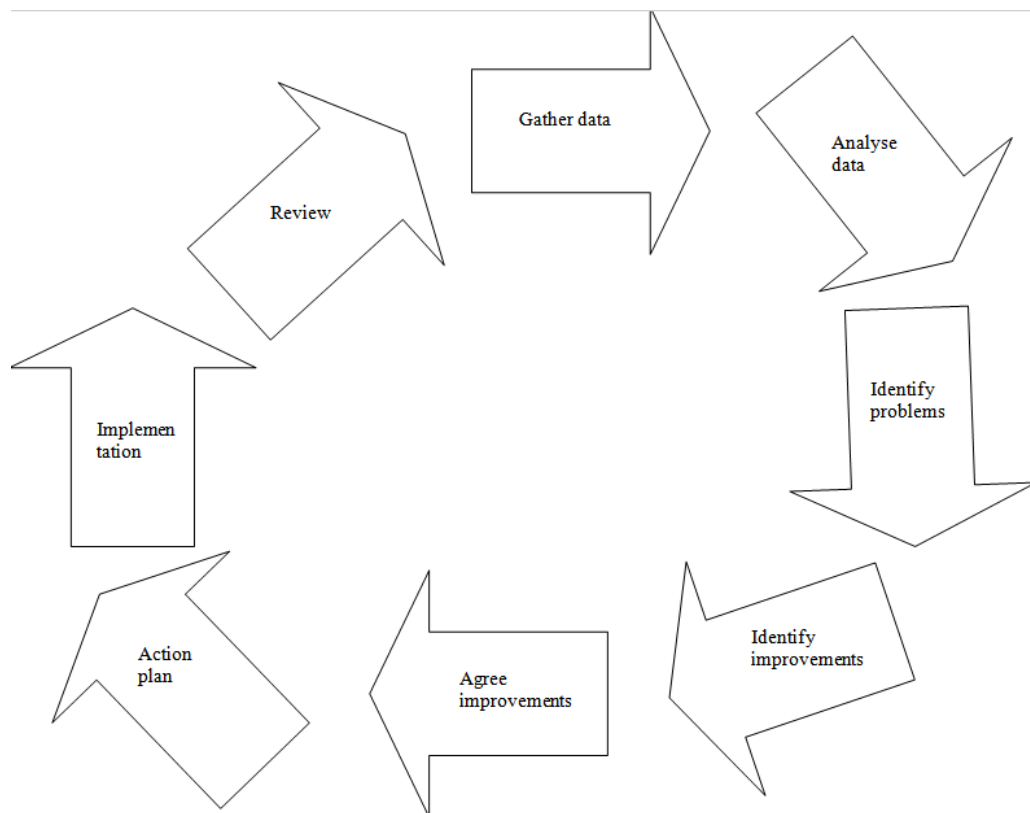


Figure 2.7: Model for CI (Mulhaney *et al.* 2004)

Management systems promote a continuous improvement approach that can lead to improvements in efficiency. This aspect of the research will now be reviewed.

2.12.2 Efficiency

Improvements to productivity can be made without the need for capital expenditure, but is this sufficient to obtain management commitment to 'buy-in'? How can they say no? It seems that often they do: does this mean that they do not know? CI methodology can be used not only to reduce problems but also to improve efficiency. The case study in this paper identifies the objective of effectively moving WIP through a business. Although a consulting group was used to improve performance, the CI techniques and tools used could possibly be simplified to help SMEs that do not use consulting businesses. The production line achieved benefits from the improvements made by reducing complexity, cycle time and inventory, and increasing serviceability (Labanowski, 1997).

Visual awareness of data and improvements can be dynamic and can motivate everybody within the business.

2.12.3 Visual Management

One of the most common barriers with visual management is keeping the information up to date. Often businesses start with good intentions but fail to keep the information up to date in the long term.

Most authors covered in this literature review agree that visual management is important. The techniques used in CI lend themselves to visual display within a business. Visual management should be simple and effective. Visual performance targets direct organisational participants towards a firm strategy, provide guidance for allocating effort, and induce effort towards achieving performance goals. These should be part of business core management control systems and should consist of two basic components: performance measures and performance targets. Further research could examine how management performance is affected by target-setting choices (Dekker *et al.*, 2012). To

improve, a business not only needs to focus on the manufacturing processes but also on the administration processes.

2.12.4 Administration Processes

For Latzko (1989), implementation of CI appears to be quite rare in an administration environment; however, the administration process can often cause problems in other processes downstream in a business; therefore, it is critical that issues in this area are resolved to prevent issues and barriers arising. There is a small amount of work that has been conducted in other areas of a business apart from the manufacturing process. This includes the executive boardroom. The principles appear to be similar to that of a manufacturing process: measure, analyse and improve.

2.12.5 Business Professionals

Brice (1989) indicates that quality professionals are used to implement CI, but these professionals are often met with resentment in a business. Lasting change requires persistence throughout the organisation. When forming teams to make improvements, conventional teams should consist mainly of technicians, engineers and managers (Scholtes *et al.* 1989). Gertsen (2001) has discovered that larger companies are more likely to implement CI, and modular product businesses tend to have more exposure than those that have standardised products. Mulhaney *et al.* (2004) make use of a recently qualified graduate to improve a business by BPR.

Anderson *et al.* (1994), Arvelo (1995), Arndt (1992) and Labanowski (1997) do not make any claims in their works that business professionals are required. However, it is interesting to note that Garcia-Lorenzo *et al.* (2000), Brice (1989) and Hall (1993) claim that such professional resources are a necessity.

A common theme exists between management systems and authors of PDCA; this will now be reviewed.

2.12.6 A Common Theme: Plan – Do – Check – Act

Bhulyan and Baghel (2005) believe that more research is required in this field for the implementation of a suitable framework that could help businesses

improve their performance. Dale (1996) has found that there are issues with sustaining a CI process that could stagnate, causing further problems in the future. All authors seem to have a common theme in their work. This is shown in Figure 2.8.

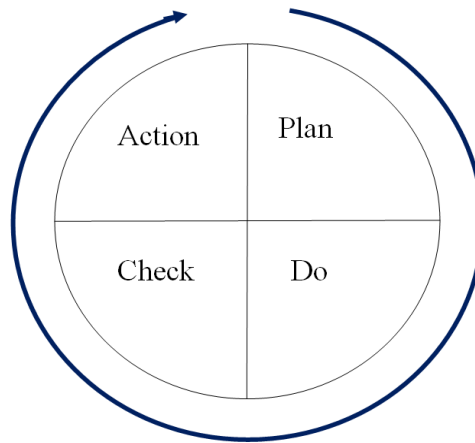


Figure 2.8: Plan-Do-Check-Act (Bhulyan and Baghel, 2005)

To promote a Plan-Do-Check-Act approach, the process of knowledge management can support people to learn more by learning by doing. Analysts in this area often promote KM as a supporting process. This research will now review this method (Bhulyan and Baghel, 2005)

2.13 Knowledge Management

2.13.1 Introduction

This additional literature review has been conducted because it is important to understand the principles of knowledge management to determine if this method can support the framework being developed in this research project. It may be possible to learn from such past research papers to help develop the framework.

Reports indicate a fundamental restructuring of economies, where some countries have experienced stronger growth than others. Some of these growth rates coincide with the adoption of new technologies, enabling greater efficiency in production units, enhancing value added for resources and reducing costs, resulting in higher productivity. Information can now be transferred instantly between persons, irrespective of distance, while complex, locally-embedded, tacit knowledge can only be transferred through physical connectivity of local spaces (Martinus, 2010).

Knowledge management is a systematic approach that promotes continuous improvement through the consideration of corporate strategic plans and the utilisation of available data already held within a company's management team. A key approach to success is to be practical, participative, people-driven and interpretative. Further research is necessary to develop a better maintenance mechanism for maintaining knowledge repositories, because knowledge has varying levels of usefulness over time, and some knowledge might no longer be relevant to a company (Keane *et al.*, 2007).

2.13.2 SMEs Struggling to Change

Most enterprises are struggling to change their existing business processes into agile product and customer-oriented structures to survive in a competitive and global business environment. In today's dynamic business environment, maximising and optimising business performance is a critical requirement for achieving business profitability and returning shareholder value. In many enterprises, knowledge is treated as a critical driving force for attaining enterprise performance goals. This is because knowledge allows a company to achieve a better business decision at the right time. Knowledge management represents a deliberate and systematic approach to ensuring the full utilisation of the organisation's knowledge base. Improved performance can occur when knowledge is added to the tasks being performed, and participants must capture knowledge as a part of their normal work. Consequently, knowledge must be embedded in the business processes (Han *et al.*, 2008).

2.13.3 Knowledge-Based Modelling

The main purpose of a knowledge-based process modelling for concurrent product development is to explore the available theory and methods. Concurrent engineering (CE) is a systematic approach to integrating concurrent design and its processes to shorten the product development process. Learning by doing and obtaining experience is a key factor for CE. Using this type of approach could be suited to other areas of a business environment by improving process effectiveness (Zhong *et al.*, 2003).

2.13.4 Knowledge Management

Knowledge management is much discussed, but businesses still fail to obtain the benefits. How can it be used and successfully applied? This question from a company representative has its roots in a practical problem experienced by many organisations that are seeking to understand and deploy knowledge management in their business. KM promises to help companies to be faster, more efficient or more innovative than the competition. Knowledge can be classified into two different types: tacit and explicit knowledge. Tacit knowledge is the personal and context-specific knowledge of a person. It is bound to the person and is difficult to formalise and communicate. Explicit knowledge, in contrast, can be codified, collected, stored and disseminated. It is not bound to a person and has the primary character of data. Problems can be solved faster and the skills and competency of the personnel can also be improved (Greiner *et al.*, 2007).

An online system has been developed and is used to support knowledge sharing (KS); it is designed to support the simple transfer of knowledge that is devoted to design and the development of methods, models and tools, enabling the sharing and reusing of distributed knowledge formats, using both explicit and tacit knowledge. Real life solutions to those problems can be obtained to help support CI within the business environment (Smirnov *et al.*, 2003).

Research into over 50 companies pursuing KM projects has revealed that organisational culture is widely held to be the major barrier to creating and leveraging knowledge assets. Interviews conducted by researchers have shown that while most managers intuitively recognise the importance of culture, they

find it difficult or impossible to articulate the culture-knowledge relationship in ways that lead to action. Executives also often use the concept of culture loosely, such as knowledge obtained from consultants, and without any real attempt to define what it means in practice. Culture is not only intangible and elusive, but can be observed at multiple levels in an organisation. The fundamental question for management is: what are the characteristics of a culture that will help a firm rapidly acquire and distribute new knowledge through the organisation? (De Long and Fahey, 2000)

Knowledge is one of the most valuable assets of a business and an important competitive factor, yet it is not always used. It evolves continually as the individual and the organisation adapt to influences from the external and the internal environment. Issues that can affect cultural barriers are a lack of management support, incentives, social networks, job security and language barriers (Rivera-Vazquez *et al.*, 2009).

Business professional engineers have used the development of on-board car safety systems requiring an 'accidentology' knowledge base for the development of new functionality as well as for improvement and evaluation of future car safety systems. The knowledge discovery in accident database (KDD) is one of the approaches allowing the construction of this knowledge base. The KDD can be described as an interactive process, involving numerous steps, with many decisions made by the user. The main steps that need to be followed are application learning, data preparation, choice of application, interpretation of knowledge, and use of the knowledge that can be extracted from a database (Ahmed *et al.*, 2003).

2.13.5 Learning from Knowledge

It is important that all knowledge about a business process is taken into consideration. This needs to be tapped by the management. Typically, one source of knowledge is often chosen over another and potentially relevant useful information can be lost. A more efficient use of these different knowledge resources is to combine them into a single representation, and this can improve the decision-making process, which will improve the knowledge gained. Further research must be conducted to make this approach globally applicable; process

models are often not confined to mathematical descriptions, and it is common to find only that cause and effect relationships exist. Also, process models of a more diverse nature will make better use of process knowledge for quality improvement (Liu *et al.*, 2009).

A number of studies indicate that practising knowledge sharing results in improved organisational effectiveness. The study suggests that hoteliers implementing knowledge sharing find the initial costs in terms of time, effort and money repaid in terms of overall hotel effectiveness. Consequently, owners gain more assets in terms of knowledge that can improve business outcomes and can also improve bottom-line profits (Yang, 2007).

Knowledge management activities, such as building databases, measuring intellectual capital, establishing intellectual capital, establishing corporate libraries, building intranets, sharing best practices, installing GroupWare, leading training programmes, leading culture changes, fostering collaboration, creating virtual organisations, are becoming more popular. However, no-one asks the big question: why? Some industries estimate that they have pegged the failure rate of technology implementations for business process engineering efforts at 70%. Most organisations of any size and scope are caught in a 'double whammy' of problems. They do not know what they know; in simple terms, they have incomplete knowledge of explicit and tacit data, information, and decision models available within their enterprise. Also, their very survival can sometimes hinge on making obsolescent what they know. In other words, often they may not know if the available data, information and decision models are indeed up to speed with the radical discontinuous changes in the business environment (Malhotra, 2005).

The concept of knowledge has been acknowledged for generations, and it has been used for achieving prosperity. However, as a discipline and a field of research, only very recently has it gained wider acceptance. The creation and transfer of knowledge has become a critical factor in an organisation's goal of being competitive. From this concept has emerged the idea of KM, which ensures that the right information is delivered to the right person in time to take the most appropriate decision. The areas of applications and the scope of KM

have increased but the underlying principles governing it remain the same. Managing knowledge in an organisation requires managing several processes, such as creation, storage, evaluation, generation, codification, transfer and application. To effectively manage competitive priorities, the senior management team plays a crucial role. While IT also plays an important role in realising the benefits of KM, it cannot make KM a reality on its own. The difficulty in most KM efforts lies in changing organisational culture and people's work habits. Therefore, the effectiveness of KM processes is determined by the active and willing participation of employees (Chawla and Joshi, 2010).

2.13.6 The Appeal of Knowledge Management

The appeal of KM, both as a research theme and an organisational strategy, has gained significant traction throughout the past decade. Xerox's employee professional technicians are estimated to have saved US\$100 million through its Eureka database. There are also other successes as a result of the implementation of KM. However, there is a dark side to KM, the competency syndrome, where organisations rely on only one or a few approaches proven in the past, to deal with all the challenges of the future. Technical people can also cease to think independently (Mahesh and Suresh, 2009). Wagner (2003) also supports knowledge transfer, recognising that it can form a competitive advantage for a business.

Law firms are a good example of knowledge-intensive service organisations, where it is predicted that KM practices will affect organisational performance. Could SMEs learn from this approach? Recently, there has been a surge of investment in KM within law firms. Knowledge input in the form of individual know-how and collective routines provides the basis for service provision to clients in a very flexible way, forming an output that meets their different needs. Using a KM approach, the following can be of benefit to the organisation: identification of key measures, assistance in enabling measures, enabling change, improving responsiveness, improving communication, and obtaining a return on investment (Forstenlechner, 2009).

So what is practical knowledge? It is 'the production of action', defined as the ability to put into effect previously acquired knowledge in specific circumstances. The multi-dimensional nature of practical knowledge suggests that it has to be learned and cannot be transferred. Learning by doing, learning by experimenting, and learning by failing (Guzman, 2009).

Construction companies have to manage their knowledge assets better if they want to survive in a competitive business world. Many organisations realise the potential benefits of knowledge management for competing in this environment, although there are many that do not (Kivrak *et al.*, 2008).

When an individual provides part of their knowledge, whether directly through communication or indirectly through mechanisms such as the use of a knowledge archive, they are engaging in KS. Accordingly, KS represents a social activity that occurs within a system where knowledge represents a resource that has a value. For individuals with performance goal orientations (KPIs), their objective is to demonstrate their competitiveness and avoid the appearance of incompetence. However, those with a learning goal orientation are interested in expanding their knowledge base, which can lead to improved performance. The process of obtaining the right balance needs to be managed to prevent the deterioration of knowledge and a loss of competence (Swift *et al.*, 2010).

2.13.7 Learning by Doing

An organisation is able to generate new knowledge through conversations between people with experience: this is known as 'learning by doing'. There are two key benefits to a business: internal performance, which is related to comparing costs, quality and customer satisfaction, and benchmarked performance, which is related to comparing the above against other businesses. Many studies that have investigated knowledge management initiatives fail to indicate that organisational culture is the main barrier to success and that a culture must be fostered.

Hutzschenreuter and Hortkotte (2010) have stated that cultural issues are an important aspect of the knowledge management process; developing

management trust is key and managers must carefully shape and adapt the corporate culture. Hence, to improve performance, a business must cultivate a culture that encourages and provides opportunities to communicate ideas, knowledge and experience (Tseng, 2010).

Arora (2002) points out that the most common knowledge management programmes involve development of a knowledge repository, and forming and nurturing communities of practice. Knowledge management has generated significant benefits for some companies but, at the same time, has been a fiasco for many others. Companies that follow a knowledge management programme with a clear and well set out vision, objectives and approaches tend to be more successful, whereas other companies, which jump on the knowledge management bandwagon with a focus on IT, are not. Aiming to reap some quick benefits without having any focus on the human side and a long-term strategy means businesses can fail. One of the objectives of a knowledge management programme is to avoid the re-invention of the wheel; using the learning process, problems of the past can be prevented. According to Arora (2002), the second objective of the knowledge management programme is to help the organisation to continuously innovate new knowledge which can then be exploited to create value. The third objective is to continuously increase the competence and skill level of the people working in the organisation. This will help in improving productivity and innovation, and in reducing the chances of making the wrong decisions in the long term. This contribution of employees is generally evaluated by experts, who may add their own tacit contribution to enrich it. Experts may be members of the communities of practice and therefore will have the responsibility to keep their part of the database updated. Using the communities of practice approach can drive strategy, start new lines of business, solve problems quickly, transfer best practices, develop professional skills and help in recruiting and retaining talents to drive competitiveness and innovation within a business environment (Arora, 2002). Should this approach be more common than it is in SMEs?

Arora (2002) states that KM is a tool that can support the creation of virtual KS. This is a software-based application that enables the sharing of knowledge related to the implementation of manufacturing excellence, using best practice

and improvement tools. Extensive literature and case studies support the belief that KM plays a key role in managing businesses successfully. The way in which an organisation learns is also a key factor in its effectiveness and potential to innovate and grow. The ability to learn, acquire, foster and integrate relevant knowledge within an organisation and also its value chain is recognised as one of the most important competencies for a firm to be successful. The failure of the early IT-based KMS has encouraged a strong tendency in KM research to focus on the softer approach of KMS development. This approach will encourage people to learn from each other through direct social communication and interaction. However, this softer approach to KM remains vague in its practical and systematic application to the successful implementation of a learning organisation. According to Arora (2002), SMEs are disadvantaged in this area due to reduced learning opportunities and a lack of trained staff and finance to develop and implement appropriate systems. Consequently, there appears to be a role for a software-based KM tool that can support organisations such as SMEs with limited resources to share knowledge to improve their business. This could be used by any type of business, regardless of size or industrial sector. In a survey of 24 businesses, the main barrier to improvement was the lack of knowledge of KM tools (Arora, 2002).

A practical methodology is required for developing a process-based KMS for supporting CI and asset management. Early, IT-based knowledge management systems were difficult to implement because they were either too narrow in scope, as in the case of expert systems, or too broad and shallow in scope, requiring extensive human interaction. Arora (2002) claims that this approach is one where, in learning organisations, individuals are constantly expanding their capacity to create and achieve desired organisational results through nurturing new ways of thinking. In addition, there has been some confusion with the repackaging of existing IT software that could have prevented a much wider use of knowledge management.

Arora (2002) states that a successful KMS also needs to create an environment that encourages users to seek knowledge for themselves or extract from sources within and beyond the boundaries of the company. This will encourage the creation of a learning organisation through the experience of implementing

processes that generate knowledge-driven CI. The structure of the process-based KMS through its application of information, knowledge and generating learning makes use of existing databases, provide information about processes and give people knowledge (Arora, 2002).

In order to design a valuable KMS, it is important to consider three key issues:

1. Users should not have to learn completely new technologies to use their knowledge more efficiently; instead they should use already known tools to create and obtain process knowledge.
2. Information awareness, accessibility, availability, input and maintenance must be taken into account to facilitate decision-making through the KMS.
3. Effective interaction between individuals and the IT system must be considered in the functionality of the KMS.

Arora (2002) supports the above points.

2.13.8 The Benefit of Knowledge Management Systems

The benefit of a KMS is its capability to drive learning, raise the knowledge level within the organisation and promote the implementation of CI to such an extent that its organisational culture can be changed significantly to transform it into a true learning organisation. Many of the features use standard tools; however, further research is required due to the surprising fact that few firms apply them at all (Barber *et al.*, 2006).

Various dissatisfaction feedback transferrals contribute to the decision-making process. Despite costly investigations into customer feedback systems, very few customer dissatisfaction feedback transferrals are connected to exploring future development actions that could help improve a business. The knowledge gained in failures is often instrumental in achieving subsequent success; in simple terms, failure is the ultimate teacher, yet it is common for there to be a lack of interest in this subject. Continual learning in this area could benefit businesses and improve performance (Fundin and Elg, 2010).

This architecture offers an initial model for an organisation that intends to facilitate knowledge flows, according to the prevailing ISO 9001 guidelines and processes, to encourage the management of corporate knowledge and effectively enhance a firm's competitiveness. Researchers interested in this field are encouraged to triangulate these findings (Lin and Wu, 2005).

Nonaka *et al.* (2000) state that despite the widely recognised importance of knowledge as a vital resource in achieving competitive advantage, there is little understanding of how organisations actually create and manage knowledge dynamically. They propose a model of knowledge creation consisting of three elements: (i) the socialisation, externalisation, combination and internalisation process (SECI), or knowledge creation through the conversion of tacit and explicit knowledge, (ii) 'ba', the shared moderators of the knowledge creation, and (iii) the knowledge assets, the inputs, outputs and moderators of the knowledge-creating process. Instead of merely solving problems, organisations create and define problems, develop and apply new knowledge to solve the problems, and then further develop new knowledge through the action of problem solving. The organisation is not merely an information-processing machine, but an entity that creates knowledge through action and interaction. There are two types of knowledge: explicit and tacit. Explicit knowledge can be expressed in formal and systematic language and shared in the form of data, scientific formulae, specifications, manuals, etc. It can be processed, transmitted and stored relatively easily. Tacit knowledge is highly personal and hard to formalise. Subjective insights, intuitions and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in action, procedures, routines, commitments, ideals, values and emotions.

The four modes of the SECI process model are as follows:

1. Socialisation is the process of converting new tacit knowledge through shared experience. Since tacit knowledge is difficult to formalise and often time and spec-specific, it can only be developed through shared experience, such as spending time together or living in the same environment.

2. Externalisation is the process of articulating tacit knowledge into explicit knowledge. When tacit knowledge is made explicit, knowledge is crystallised, thus allowing it to be shared by others, and it becomes the basis of new knowledge.
3. Combination is the process of converting explicit knowledge into more complex and systematic sets of explicit knowledge, which is collected from inside and outside the organisation.
4. Internalisation is the process of embodying explicit knowledge into tacit knowledge. Explicit knowledge created is shared throughout the organisation and converted into tacit knowledge by individuals. It is closely related to 'learning by doing'.

Based on the knowledge vision of the company, the senior management team has to facilitate dynamic knowledge by taking a leading role (Nonaka *et al.*, 2000), this can prevent the barrier of a lack of commitment.

Work has been published on Communities of Practice that will be considered for inclusion into the framework. The next sub-section will review the available literature.

2.14 Communities of Practice

Today's economy runs on knowledge, and most companies work assiduously to capitalise on that fact. They use cross-functional teams and are customer-driven, product-focused businesses. However, knowledge and the use of its application are critical to success in supporting the business improvement. Communities of practice can quickly support a team in solving problems (Wenger and Snyder, 2000).

The term knowledge management, when used to support communities of practice, has had its detractors. Some people have even claimed that it is an oxymoron; when it comes to knowledge, they say, the term management does not even apply. Others have criticised the IT focus that the term suggests. Yet

the term also makes sense; if knowledge is a strategic asset, it has to be managed like any critical organisational asset. It is too important to be left to chance. Knowledge management requires the correct organisational context and processes to be in place to co-ordinate the management of knowledge and integrate it into business processes. Items such as technology for information flows, interpersonal connections and document repositories, as well as institutional and cultural norms of paying attention to knowledge, are all necessary (Wenger and Snyder, 2000). Figure 2.9 shows the cyclical doughnut model that can be integrated into an organisation to connect strategy to performance. This can help a business to focus on knowledge development to improve a business.

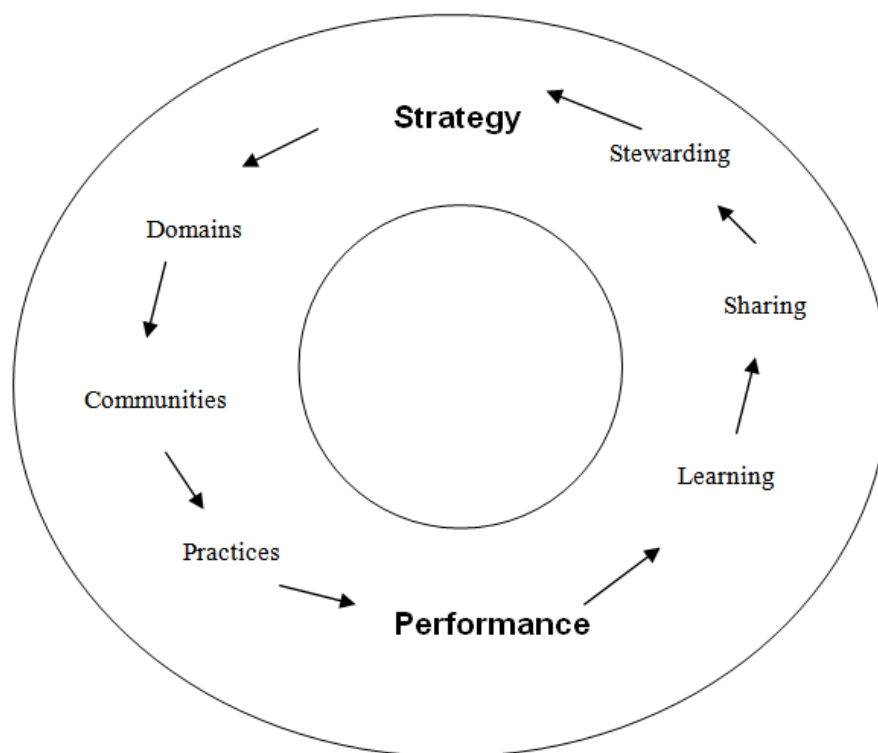


Figure 2.9: The doughnut model of KM, (Wenger and Snyder, 2000)

For Wenger (2004), communities of practice are groups of people who share a passion for something that they know how to do and who interact regularly in order to learn how to do it better. From this perspective, the author states the role of the professional manager is not to manage knowledge directly but to enable practitioners to do so by sharing their experiences to understand their

difficulties and the knowledge that has been gained. There are three elements to a community of practice:

1. Domain: the area of knowledge that brings the community together
2. Community: the group of people
3. Practice: the body of knowledge, methods, tools that members use.

Wenger (2004) supports the above three points.

When the experience has been conducted, the learning process can be recorded as knowledge.

According to Roberts (2006), Communities of Practice are not stable or static entities; they evolve over time as new members join and other leave. Managers need to have a role supporting the development of communities of practice as they are not without weaknesses or limitations. While trust is a strength, it can become a hostage to driving improvements and also may suffer where weak community spirit exists. SMEs may be less able to exploit methods of knowledge management.

Easterby-Smith *et al.* (1998) support a Communities of Practice approach because firms cannot rely on established practices and need to invent new processes and technologies to learn new ways of doing things. This will enable them to compete with other businesses in the world. The prevention of problems is important in the process of business improvement. This aspect of business improvement will be reviewed next.

2.15 Root Cause Analysis and SMEs

ISO 9001 (2008) encourages SMEs to use root cause analysis to prevent problems by the Plan Do Check Act method. This approach should help to continually improve the business by seeking effective solutions. However, ISO 9001 does not provide any details on how to implement Plan Do Check Act; nor does it refer to any of the continuous improvement techniques that are freely

available that could support the process of achieving a root cause analysis. ISO 9001 promotes competence in employees but, again, does not provide any guidance with regard to root cause analysis. SMEs that are not aware of the ISO 9001 approach of Plan Do Check Act or have not had exposure to publications on root cause analysis would not benefit from this approach.

Arndt (1992) promotes the use of root cause analysis; yet, there appears to be barriers that prevent businesses from using them, this is also supported by Bhat and Rajashekhar (2009) and Gatchallan (1997). For Brown and Eatock (2008), larger companies apply such CI methods yet SMEs do not. According to Cayer (2007), choosing the appropriate business improvement tools is very important. Also an important factor is balancing the cost of reporting the problem with solving it. If there is an imbalance, companies are less likely to report problems and, therefore, the root cause of the problem will not be found and it will continue. Chapmen and Sloan (1999) also support the view that smaller businesses are less likely to use a root cause analysis approach; larger companies are more likely to implement continuous improvement than smaller companies (Gertsen, 2001).

There is a gap, and this will now be discussed in the next section of this research project.

Businesses are under pressure to achieve in today's busy environment. The literature has identified CI techniques that have been available to SMEs for many years, however not all SMEs make use of them to improve their business performance. In the available international publications across a range of years and countries, most authors explain the use of CI techniques in different business environments. The barriers are well documented and also the benefits; however, they are not quantified. With the various types of CI techniques that are available, different levels of knowledge for effective use are not required. Histograms, brainstorming, the five whys and cause & effect have an immediate impact when used and are rapid to learn, especially for people with no prior knowledge of the use of CI techniques. There are also process models, such as TQM, Six Sigma and Kaizen, which use an arrangement of CI

techniques; however, they appear to over- complicate projects, resulting in project failures.

The issues encountered by authors who have published papers will be taken into account for the development of the framework to help business improve their business performance. The framework will contain selected CI techniques that will have an impact supported by KM, which will support people to make use of the CI techniques. Communities of Practice will enable the spread of KM to people who also want to improve business performance by learning from others who have gone through the experience of using the framework.

Odouza *et al.* (2008), in their research, have identified that CI barriers have caused a gap of the uptake of business improvement and thereby prevent improvements taking place. This is a result of the failure by the management to have any commitment to improvement projects, and this will prevent any successes being achieved. This gap is also supported by other authors: Arvelo (1995) and Gatchallan (1997) also support the view that the lack of top management involvement can halt any improvement projects.

However, there are other authors who have not pointed to any barriers which include Vazquez *et al.* (2012); Hines and Rich (1997) and Mulhaney *et al.* (2004). These authors have failed to identify problems or have only focused their research on businesses that only encountered successes with CI programmes and did not encounter problems.

2.16 Summary

This literature review has identified that barriers exist between the available CI techniques and the manufacturing capacities of SMEs. Further research, using suitable methodologies, will determine what is actually happening in industry and enable the development of a framework. This framework will make use of a selection of CI techniques, and give SMEs the confidence to utilise CI techniques to reduce waste and improve business efficiency.

Conducting a KM literature review of international authors has identified that there is a need to include the approach in the framework. The authors identify the benefits and also some potential problems; however, the principles of KM, Soft Systems and COP shall be considered for inclusion into the development of the framework. A knowledge bank could be developed to store information from past successful projects.

KM has a key role in this research in the transfer of knowledge by practice and through past experiences from one person to another. A simple approach will be developed for the framework to enable SMEs to gain from the benefits of other business professionals.

The next section in this research uses the knowledge obtained to develop a framework concept that will help business to improve their business performance and thereby avoid the barriers encountered by previous researchers.

Chapter 3: Research Methodology

3.1 Introduction

This chapter identifies the research philosophy and methodology for this thesis. It reviews what is actually happening in manufacturing SMEs regarding improving business performance. The research methodology chosen for this study consists of four aspects. These are:

- A literature review based on professional journals, books and conference and seminar proceedings
- A postal questionnaire which was implemented prior to the development of the concept framework. The questionnaire was sent to SMEs to establish if a gap existed between the available literature and SME practice. The questionnaire was sent to 800 SMEs in the UK; 50 replied, with the most common barrier to business improvement identified as being top management commitment
- Case studies to validate and develop the framework in Figure 3.6.
- Observations and interviews used to identify and confirm the research problem and to obtain feedback as part of the validation

3.2 Research Philosophy

Research methodologies were researched from academic publications to provide the process for ensuring that a suitable research approach and philosophy were adopted for this research project. The following sections outline a series of methodologies that have been used in this area.

3.2.1 Axiology

Hayes and Braun (2010) have noted that axiology is the value, worth and logic defined in a study. Because humans are linked with ethics and because ethics

is based on values, it is possible to build an axiological summary of entrepreneurial human action which can also result in innovation within processes.

Connor (2006) states that a value science is where humans need to experience reality and make decisions. Systemic thinking about ethics is all about moral code. It speaks of respect for rules, understanding of the goodness and badness of actions and clarity of ethical principles.

Saarni (2011) has argued that axiology emphasises the insight that science and technology are a social activity governed by norms and values of various kinds. Axiology normally adopts a six-step approach: identification and analysis, identifying stakeholders, selecting relevant questions, identifying issues, obtaining knowledge, analysing questions based on new knowledge obtained and summarising the most important values.

Wood (1997) has noted that, in today's society, there is insufficient time spent discussing right from wrong. Axiology can fill this gap by supporting a person's desire to discuss and debate the hierarchy that rules people's lives.

In this research, an axiology methodology approach will consider human aspects and values in order to make a success of the framework. Wood (1997) states that for human interaction to occur, it is important to ensure that problems are identified, discussed, debated, brainstormed and analysed, and that collective solutions are discovered. Stakeholders must be committed to the success of each project. Through the learning process that people go through, their knowledge will be increased.

This research is involved with people in a business environment, and this methodology will take into account the human aspects of this setting.

3.2.2 Ontology

Kumazawa (2014) has stated that focusing on ontology engineering as a method of knowledge structuring supports the co-deliberation of processes. Ontology engineering is a method in knowledge engineering that allows

computers to be used in the structuring process. Ontology can be used to support knowledge sharing.

Holsapple and Joshi (2004) have argued that ontology provides a simplified and explicit specification of a useful phenomenon because it can explore components that define such a phenomenon, which can help in systematically understanding or modelling it. Ontology provides a common vocabulary and frame of reference that can enhance communication and sharing among practitioners.

Garzas and Piattini (2005) have noted that ontology describes domain knowledge in a generic way and provides an understanding of it. It can help in the following ways: structuring and unifying accumulated essential knowledge, improving communication, teaching concepts and their relationships, sharing knowledge and resolving terminological incompatibilities.

LePendou and Don (2011) have asserted the importance of providing a means of formally specifying complex descriptions and relationships about information in a way that is expressive. The development of an ontology database is useful for answering ontology-based scientific queries that require taking the assumption of hierarchy and other constraints into account. Ontology provides a simple and explicit structure to keep projects focused on obtaining knowledge to ensure a systematic approach to solving problems, using effective communication where new knowledge is obtained.

This methodology will provide a framework to obtain information from the case study to support the further development of the business framework.

3.2.3 Epistemology

Handriana *et al.* (2013) have proposed that something can be considered as a science when it includes at least six components: problems, attitude, method, activity, conclusion and effects. Science is a body of knowledge which is classified and systemised, organised around one or several core theories and a number of general principles. It is usually expressed in quantitative terms, that is, knowledge that allows predictions and questions the process that allows the

gaining of knowledge in the form of science and what needs to be watched so that new knowledge can be obtained.

Hars (2001) has noted that epistemology supports science and depends upon communication between researchers and on access to the wealth of scientific knowledge generated by the scientific community. Knowledge, once stored in journals and books only, was accessible in libraries; now, infrastructure is changing to provide access to information on-line, which results in the provision of instant knowledge.

Rawwas *et al.* (2013) have pointed out that epistemology is the belief in an ethical process that is susceptible to the intellectual virtue of experiences. Open mindedness, curiosity, careful thinking, creativity and intellectual courage are the foundations of epistemic values.

The aspects mentioned above are key to the research project and will provide guidance and structure for it. Figure 3.1 shows the research for the framework to support business improvement. A comprehensive literature review was conducted to determine barriers that result in a gap of CI techniques being used in SMEs. To determine if companies were actually using CI techniques in practice, 800 SMEs were sent a postal questionnaire, and 50 SMEs replied. The analysis shows that not all SMEs used CI techniques to improve their business performance. Barriers existed, such as poor management commitment and a lack of CI technique knowledge. After obtaining information from the literature review and the postal questionnaire about the possible techniques and tools that could be used, a concept framework was developed. The concept framework was then validated in a case study environment of SMEs with a low volume and also a high volume product. Structured interviews obtained value information about the performance of the concept framework and ideas for its improvement. A conclusion and recommendations follow the documenting of the findings. The planning of the research was important in order to ensure that all of its aspects would be completed successfully.

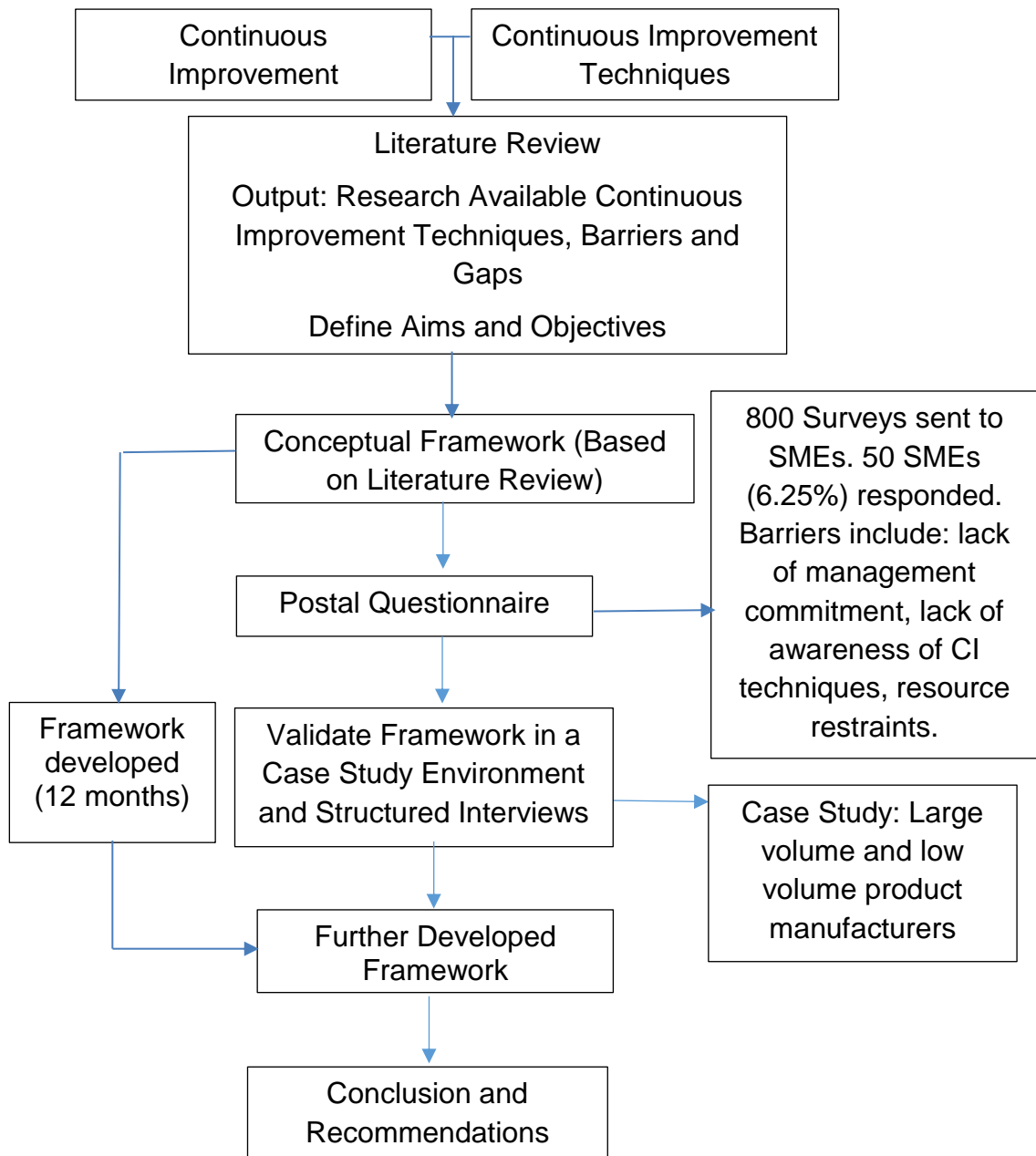


Figure 3.1: Research approach

3.3 Research Planning

Researchers should ask is why it is important to produce a research plan. A research design aims to set a path to be followed. Asking questions about what research intends to achieve is important when planning the route to take. Research can be considered as an intellectual puzzle, and planning is crucial

for the allocation of such resources as time, money, equipment and transport. This approach can also be used for quantitative research (Mason, 2002).

Table 3.1 shows the advantages and disadvantages of different data collection methods and the situations for which they are best suited. The researcher will consider this table for future work. Research planning helps to support the preparation of the research in reaching conclusions.

Table 3.1: Qualitative Data Collection Types, Options, Advantages and Limitations (Cresswell 2003)

Data Collection types	Options Within Types	Advantage of the Type	Limitations of the Type
Observations	<ul style="list-style-type: none"> Complete participant: researcher conceals role Observer as participant: role of researcher is known Participant as observer: observation role secondary to participant role Complete observer: researcher observes without participating 	<ul style="list-style-type: none"> Researcher has a first-hand experience with participants Researcher can record information as it is revealed Unusual aspects can be noticed during observation Useful in exploring topics that may be uncomfortable for participants to discuss 	<ul style="list-style-type: none"> Researcher may be seen as intrusive "Private" information may be observed that the researcher cannot report Researcher may not have good attending and observing skills Certain participants may present special problems in gathering rapport, for example children.
Interviews	<ul style="list-style-type: none"> Face-to-face one on one, in person interview Telephone; researcher interviews by phone Group participants in a group 	<ul style="list-style-type: none"> Useful when participants cannot be observed directly Participants can provide historical information Allows researcher "control" over the line of questioning 	<ul style="list-style-type: none"> Provides "indirect" information filtered through the views of interviewees Provides information in a designated "place" rather than the natural field setting Researchers presence may bias responses People are not equally articulate and perceptive
Documents	<ul style="list-style-type: none"> Public documents such as minutes of meeting and newspapers Private documents such as journals, diaries and letters E-mail discussions 	<ul style="list-style-type: none"> Enables a researcher to obtain the language and words of participants Can be accessed at a time convenient to the researcher, an unobtrusive source of information Represents data that are thoughtful, in that participants have given attention to compiling As written evidence, it saves a researcher the time and expense of transcribing 	<ul style="list-style-type: none"> May be protected information unavailable to public or private access Requires the researcher to search out the information in hard-to-find places Requires transcribing or optically scanning for computer entry Material may be incomplete The documents may not be authentic or accurate
Audio visual materials	<ul style="list-style-type: none"> Photographs Videotapes Art objects Computer software Film 	<ul style="list-style-type: none"> May be an unobtrusive method of collecting data Provides an opportunity for participants to directly share their reality Creative in that it captures attention visually 	<ul style="list-style-type: none"> May be difficult to interpret May not be accessible publicly or privately The presence of an observer (e.g.: photographer) may be disruptive and affect responses

3.3.1. Preparation

Posing research questions and building a conceptual framework around them can extract information that can help in developing an overall strategy. Planning the use of resources is key to the success of such projects (Marshall and Rossman, 2006).

The researcher wrote and employed this study's postal questionnaire with the objective of facilitating analysis and identifying what CI techniques SMEs use. Its format followed principles documented in the literature. A few key questions were selected with the objective of generating interest and ensuring a good response rate; the questions selected for inclusion were intended to prompt the respondents to want to obtain more information, thereby making them more likely to participate in this research project. The information that the questionnaire obtained could be compared with the framework concept for congruency.

The questionnaire was aimed at SME operators in a range of industries across the UK because more could be learnt from many different industries over a wide geographical area than from a localised and restricted sample, which is part of the research strategy.

3.3.2 Research Strategy

It is important to have a research strategy that will provide the framework and structure to support the aim of the research. This study's purpose is to design and develop a framework that can help SMEs to reduce business waste. It will use the case study method to validate the framework, and also use observations, documents, questionnaires and interviews to support this process (Hines and Rich, 1997). The framework will be offered as a means to help businesses to improve business performance based the international literature and initial research in the Midlands region of the UK (Oduoza *et al.*, 2008). The initial work conducted formed the pilot study to test ideas to see if they would actually work in a business environment.

3.4 Pilot Study

The researcher had already completed a small survey in the Midlands region of the UK before launching this study. The results stimulated interest in obtaining more data from a larger sample (Oduoza *et al.*, 2008). The response to this pilot study was relatively low, prompting the idea of producing and implementing an incentive letter to be sent out with the questionnaire. The pilot study was based on what had been learnt from a comprehensive literature review.

In the research by Oduoza *et al.*, (2008) a pilot study was also tested at an engineering business that employed 400 people and produced a wide range of high-precision and high-volume fabrication components. The processes were sales, design, purchasing, project management laser, punching, welding, painting and assembly. Several projects were used as the basis for initially validating the framework for design, suitability, ease of use and success all of which identified root causes of problems.

3.5 Literature Review

A comprehensive literature review of papers and books has been conducted to determine what CI techniques and tools are available to support SMEs in improving their business. That CI techniques are easily available has been identified, although not all SMEs adopt their use. The literature review conducted in Chapter 2 has identified barriers (Oakland and Tanner 2007). Therefore, it is important to review the detail of barriers from not using CI techniques in the development of the framework in this thesis.

3.6 Research Data Analysis Tools

3.6.1 Qualitative Data Analysis

This research uses both qualitative and quantitative data analysis tools the following data analysis tools in this research.

Isaacs (2014) has stated that qualitative research methodology enables researchers to explore social and behavioural needs. It can be used in a variety of applications that include studying social, cultural, economic and political applications, examining interactions between groups, and exploring people and their communities.

Ingham-Broomfield (2014) is of the view that qualitative research is a means of testing objective theories by examining the relationship between variables. A variable is a factor that can be controlled or changed in an experiment.

Sallee and Flood (2012) have asserted that qualitative research can serve as a great resource for policymakers and practitioners. It can enable the collecting of plentiful data in a timely, cost effective manner, and such findings can be generalised.

Hancock (2002) is concerned with developing explanations of social phenomena. For him, qualitative research aims to understand the world we live in and why things are the way they are. It is concerned with the social aspects of our world and seeks to answer questions about why people behave the way they do, how opinions and attitudes are formed, how people are affected by the events that go on around them, how and why cultures have developed in the way they have and what the differences between social groups are.

3.6.2 Quantitative Data Analysis

The word quantitative implies quantity or amounts. Perl and Noldon (2000) have expressed the view that quantitative studies assume a value-free or objective method for arriving at generalisations. Most surveys are designed to explore the characteristics of a sample population. Survey research designs are often used to answer questions that pertain to characteristics; this is useful when studying data. As with any new research focusing on human subjects, the data gathered depends on the respondents' willingness to provide accurate information.

Muehlenhause (2011) has stated that before anything else you must know what you are trying to answer. Deciding upon the specific research questions is one of the most important decisions to be made in the research process. This is because the researcher will be quantifying what he deems important in

answering preselected research questions. Sometimes random samples will not allow the researcher to answer the questions he is exploring. It is important that convenience samples or selective sampling be used. One has to be certain that one is asking all of the research questions one wants to answer; research questions should never be formulated after the analysis has been completed.

Thamhain (2014) has noted that quantitative approaches are often favoured in supporting project evaluation and selections if the decisions require economic justification. They are commonly used to support judgement-based selections. One of the features of quantitative approaches is the generation of numeric measures for simple and effective comparison, ranking and selection.

Fassinger and Morrow (2013) have stated that quantitative approaches can provide large representative samples of cultural communities and assert cause and effect relationships as well as conform or disconfirm theoretical hypotheses. Also, a quantitative approach can summarise numerical data in ways that are clear and persuasive to leaders and policymakers.

Samejima *et al.* (2010) and Zhang and Zhao (2015) have applied quantitative approaches to their research to express their findings for research into business evaluation and the behaviour of container shipping.

3.6.3 Qualitative and Quantitative – A Mixed Approach

Thamhain (2014) and Fassinger and Morrow (2013) have suggested a mixed approach using both qualitative and quantitative approaches to support research projects.

3.7 Case Studies

Yin (1993) has noted that case study research can be applied in many environments, such as those of service, education and law enforcement agencies. Case studies can support methodologies in achieving the aim and objectives of the research. A case study can help identify the cause and effect of a given research issue.

Case studies are a common scientific tool that can be used to trial, explain and criticise CI techniques. In order to gain a better understanding of waste minimisation, on-site case studies are used to develop principles that can help businesses (Seth and Gupta, 2005; Hines and Rich, 1997; Brunt, 2000).

Szendel and Tighe (1994) have supported the use of case studies to study the Kaizen approach, which involves observing the situation, defining the changes and then making the changes happen. The case study approach can demonstrate the efficiency of the concept of a framework for achieving future changes (Hines and Rich, 1997).

A research methodology based on case studies can also be used. Case studies are the best way to obtain a high degree of validity with practitioners, and also fit well with the objectives of refinement theory. They are also particularly suitable for the development of new theories and ideas (Lasa *et al.*, 2008). They have been particularly useful in the development of operations management theory, having supported the creation of many new concepts (Lasa *et al.*, 2008).

The case study used in this research applies a selection of the methodologies detailed in the chapter to achieve its aims and objectives. The focus of this research is on business improvement without the assistance of business professionals. The researcher therefore decided not to use participant observation, instead engaging in non-participant observation to retain distance and avoid interacting with the processes being observed. The purpose of these observations was to discern whether management support and commitment is vital to the success of any projects (McQuater *et al.*, 2000; Arvelo, 1995; Brice, 1989; Mulhaney *et al.* 2004; Lawrence, 1983; Oakland, 2000).

A common theme from the available literature on methodologies is the importance of accurate data collection.

3.8 Data Collection

It was decided to develop some questions to determine what was actually happening in an SME environment. The questionnaire was based on what was

found in the literature review and also provided useful knowledge that could be used to develop the concept framework. The questionnaire posed questions on areas such as knowledge of improvement projects, barriers to improvement and CI knowledge. It was decided to contact 800 SMEs in the Midlands, UK local to the researcher in the event that the businesses would like to be involved in case study work. Also, Thompsons Directories advised the researcher that the Midlands, UK was highly populated with manufacturing SMEs. Fifty replied and their responses were later analysed.

The literature relies on a small number of case studies rather than taking a broader quantitative approach. This research questionnaire was designed to obtain more information than was obtained by the studies in the literature review.

This study required a well-designed questionnaire, and the researcher therefore referred to Oppenheim (1992) when developing the questions. Postal questionnaires generally receive a good response when seeking information (Gertsen, 2001).

To obtaining further detailed feedback in the form of interviews is considered in the next section.

3.9 Interviews

Conducting interviews structured around a specific project can produce a better understanding of the processes involved. Data collected from other methodologies can be discussed and a structured approach achieved (Arbulu *et al.*, 2003). Information obtained from personal interviews with directors and managers can provide valuable knowledge that can help with decisions on how to improve (Garcia-Lorenzo *et al.*, 2000), and interviews with key cross-functional staff can show up areas of inefficiency (Jones *et al.*, 1997).

To support interviews the process of open-ended interviews was also considered.

3.9.1 Open-ended Interviews

The aim of interviews of this type is to identify more general potential issues that could prevent the framework from minimising waste within the interviewees' organisations. It gave the opportunity for people involved in the case study to communicate what they saw as its strengths and weaknesses, including any flaws in the case study, and their personal views (Oduoza *et al.*, 2008). Discussions conducted with interviewees allowed for more detailed information to be considered for this study, and also for the discussion and consideration of their ideas for improvement.

The researcher used specific techniques, such as cause and effect, histograms and flowcharts to analyse the information obtained from the open-ended interviews, and used any specific relevant information that could help to improve the framework. This method provided not only specific detail, but also an overall view of the businesses and the potential effects that the framework could have on them. Focused interviews were also considered to specifically focus on certain aspects of the research.

3.9.2 Focused Interviews

The objective of the focused interviews was to obtain more information about a specific part of the research and process model and to explore several topics further. These topics were: (a) business pressures on the organisations involved; (b) waste minimisation issues; (c) barriers to wanting to improve; (d) gaps in knowledge of CI techniques identified in the literature review; (e) knowledge transfer from the available academic literature; (f) management commitment to waste minimisation; (g) specific training in CI techniques, and (h) experience of failed improvement projects.

The researcher conducted focused interviews with top managers, supervisors, engineers, shop-floor workers and administrators. These were of a structured type.

3.9.3 Structured Interviews

The researcher conducted structured interviews to understand the reasons for SMEs' low uptake of CI techniques. Structured interviews and surveys were

used to obtain quantitative data about the businesses involved addressing administration and manufacturing processes that could be used to monitor improvements. The specific areas within these businesses that could be used to measure and improve waste minimisation were: (a) lost time due to incorrect customer specifications at the contract-review stage; (b) insufficient communication; (c) lost production time due to incorrect drawings; (d) the cost of incorrect bills for materials; (e) poor planning; (f) supplier issues; and (g) process maintenance downtime.

These interviews also reviewed the TPS's seven identified areas of waste, which are: overproduction, waiting time, transport, inappropriate processing, unnecessary inventory, unnecessary motion and defects (Hines and Rich, 1997). The researcher analysed the information obtained from these interviews and, if relevant, included it in the framework.

The experts interviewed included researchers and delegates from international conferences. The industry practitioners interviewed included an operations manager, a sales manager, a design manager, a purchasing manager, a site manager, a production manager, engineers, operators and administration staff. Any observations made during the research had the potential to provide valuable information to ensure that the framework would work in a business environment.

3.10 Observations

SME operators invited the researcher to visit them and made him familiar with their operations, with the assurance of confidentiality for their businesses. The researcher made observations of all these businesses and used them for the further development of the concept framework. The researcher used the observations from these visits to collect both qualitative and quantitative data. The qualitative data involved process problems, administration problems, a lack of training, communication problems and a lack of management support. The quantitative data included business performance measures, current waste measures, quality statistics and process efficiencies.

One observation for each case was conducted at the start and end of the case study, and monthly observations were conducted over a period of 12 months.

The researcher then compared the interview findings with the academic literature and used relevant information to develop the process improvement concept framework further.

The researcher considered a soft systems approach to support the research, which is detailed in the next section.

3.11 Soft Systems

Checkland (1986) provides a systems thinking approach, a methodology which looks at the whole environment of a situation that requires improving, rather than focusing on a particular point. It is supported by KM, involving people and the transfer of knowledge, which will be key to the success of this research thesis. The world is a very complex system, but perhaps the most surprising thing about the mysterious world in which we live is that it is intelligible. Systems thinking makes conscious use of the particular concept of wholeness captured in the world 'system' to order our thoughts. 'Systems practice' then implies using the product of this thinking to initiate and guide the actions we take in the world.

A systems thinking, system practice approach was published 20 years ago, and there are relevant points that could still be used in the development of the framework in this research (Checkland, 1986). Soft systems methodology (SSM) has been successfully used by Checkland and has generated considerable academic debate. One of its strengths is claimed to be its practical usability in a wide range of situations by people without technical backgrounds, but the extent of use by non-academics has never been established. The reasons for not using SSM largely fall into three camps: lack of knowledge, difficulties within the organisation and perceived characteristics of the methodology. By far the most common benefit mentioned is that SSM provides structure. The authors provide evidence of the success of SSM; however, there

has always been some doubt that it could be easily be used by others (Mingers and Taylor, 1992).

An SSM approach incorporates as many different perspectives as possible and to tackle problems through enlargement and synthesis rather than by focus and analysis. It has also been argued that SSM does not provide adequate guidance for addressing the role of technology (Vidgen, 1997).

Lewis (1992) has reviewed SSM to look at the rich picture in the use of a soft systems approach. SSM is an approach for bringing about improvements in situations in which people play a major role and where the problem cannot be without distortion, formulated in terms of choosing between alternative means of achieving predefined objectives. Due to the fact that SSM is a methodology rather than a method, there is no standard form for its use. Lewis (1992) sometimes it is necessary to see the problem situation in a more structured way, but without commitment being made to any particular solution, or even a particular kind of solution. There are misunderstandings about the use of SSM, especially from people with limited knowledge.

3.12 Outputs

The methodologies being used in this section are well established, well proven and will support this thesis project. The methodologies will support the identification of CI techniques that are available from the literature review. Obtaining information about what is actually happening in industry is important. The questionnaire will provide this information. Case studies with interviews, open-ended interviews, focused interviews, structured questions, surveys and observations, backed by both a qualitative and quantitative approach, will support valuable information that can be used to develop and validate a framework that reduces barrier and actually works. The type of methodologies have been carefully researched and planned to help deliver the output. This data will be used to develop the framework defined later in this research project, as detailed in the case study.

3.13 Details of the Case Studies

The case studies have been conducted with two businesses with different industrial processes and of different sizes. The objective of the case studies is to identify improvements using the framework for management implementation. Detail of the case study companies are in Chapter 6.

Both case study companies made the researcher aware that there were problems at the businesses that, if solved, could improve business performance.

3.13.1 Problems Identified at the Businesses

A review was held with both case study businesses to establish which problems were affecting business performance. One common barrier identified that caused problems was that there was very little senior management commitment to preventing problems. It was also clear that there was no understanding of quality techniques that could be implemented in the business in order to minimise business waste.

Case Study 1 issues consisted of:

- Tooling: the process has stopped due to production tooling being broken or worn out, meaning there is no tooling available to manufacture components.
- Waiting for a setter: the process cannot manufacture components because there is no setter available to set the machine to produce parts.
- Setting: there is a setter available and the machine is currently being set.
- Waiting to be set: the machine has just completed the last components of a batch and requires setting for the next production run of manufactured components.
- Waiting for material: there is no material available, therefore no components can be manufactured.

- Electrical: the process has broken down and is not producing components because of an electrical fault with the machine.
- Waiting for instruction: the machine is capable of producing components but the machine is not producing components because a specific instruction is pending from the management.

Case Study 2 issues consisted of:

- Manufacturing cannot produce components because of a long lead time for drawings from the design department.
- Manufacturing cannot produce components because of a long lead time in Bills of Materials from the design department.
- Components have to be part sprayed and moved to complete the paint process because the paint booth is not large enough to powder coat components.
- Inconsistent paint thickness causes quality issues.
- Static shocks are causing a potential health and safety issue.
- There is a significant volume of powder coating paint waste due to the powder coating paint not being recycled.
- There are large holes in the curing oven that causes significant heat loss.
- Component damage is occurring because the jigging trolley is not strong enough to support the components during internal transport in the factory.
- Masking tape is currently used once and then thrown away; this is resulting in a large cost from using masking tape that is £25 per metre a roll.

3.13.2 Documentation and Data Control

It is important to have controlled documentation and data control. The researcher utilised documentation such as academic publications, reports, responses to questionnaires, interview notes, letters, meeting minutes, case study notes, concept ideas and planning notes and electronic data in Microsoft Word and Excel formats.

Documentation collected for this research was used to support the develop of a sustainable framework for the use by manufacturing SMEs. The researcher also used specific company data to support it's the analysis process.

The researcher received privileged information from the case study SMEs, which they provided in the expectation that their business information with regard to performance data would be kept confidential, and this wish will be respected throughout this thesis. Their business trading names will also be kept confidential. On the completion of this study, this information will be shredded and destroyed.

3.13.3 Data Collection in the Case Studies

Data was available in Case Study 1 and collected on a weekly basis; however the management of the business did not review, analyse or take actions for business improvement. The data already available in Case Study 1 was used to identify business issues that could be used in the case study.

Case Study 2 did not collect any data on business issues. People who were involved in the case study were involved in the process of reviewing current methods of operation; problems were then identified from the case study.

Impact of the Pilot Scheme

The same approach used in the pilot scheme was also used in the case study work for Case Study Companies 1 and 2. Using the methodologies detailed at the beginning of this chapter, the issues identified in Case Studies 1 and 2 were used as the basis of the case study. Five people from both case study companies were shown the framework and began to use the framework to

identify solutions to the problems. A detailed account is documented in the case study section of this thesis.

A review with the people involved with the case study proved that the framework worked as designed. After completing the case study work, it was discovered that in order to be successful, not all CI techniques that were originally included in the framework were required. The framework was modified accordingly; the final framework is shown later in this thesis.

3.14 Data Analysis

The analysis of the data was conducted following the pilot study, case study and the structured interviews. The analysis showed a common problem, this was a lack of management commitment to seek root causes of process problems and thereby a failure to implement actions to improve the businesses.

Isaacs (2014) has stated that case study and interview information is obtained as qualitative data and that this is useful for analysis purposes. The first step in qualitative data analysis is immersion in the data, where the researcher re-reads the interview manuscripts. Whilst reading through the information, the researcher asks what stands out or strikes them as being part of the answer to the study questions. In order to remain focused on the research question, the researcher will need to go back and forth between the data, the study aim and the theoretical framework.

Fassinger and Morow (2013) have identified that obtaining information from communities in the form of questionnaires can take many forms. For example, data can come from quantitative approaches to data collection, and questionnaires may be made available in various formats: online or paper and pencil. Specific activities used in data gathering also need to be appropriate to the cultural characteristics of the participants. Focus groups, participant observation and in-person interviews can be used for data collection. Follow-up checks should be relevant and meaningful. Fassinger and Morow (2013) summarising the results or outcome provides a final opportunity for researchers

to demonstrate their respect for participants and their responsiveness to community needs. Accurate conclusions of the data can then be presented.

Thamhain (2014) has stated that effective data analysis can add value to the project consistent with the organisational objectives, confirming resources costs for personnel and facilities, readiness for further projects and, most importantly, management belief and desire.

Muehelenhouse (2011) has defined how valuable information is obtained, and how the data will provide the most insights across all the tests run. If nothing else, it will quickly tell us which variables are worth examining further.

The pilot study in the form of a descriptive statistics questionnaire was originally carefully designed to support the data analysis process that would be required. This was achieved by designing the questions that were based from what had been researched in the literature review. The questions were wide reaching in a range of areas & disciplines with the objective to obtain precise information. It was, however, critical not to create a complicated pilot study that would result in no response from the SMEs that the questionnaire was sent to. Data from the questionnaire was extracted carefully to begin to build the foundation and later the conceptual framework. The analysis of the data obtained from the pilot study was used to develop a conceptual framework. A theoretical feasibility was conducted to determine if the conceptual framework could then possibly work in a business environmental without any major modifications. This would benefit from not having to conduct a further pilot study.

The data from the two case study companies that used the framework to identify the root causes in their SMEs was later carefully analysed. The case study data was reviewed to determine if the framework would actually work as designed. The design of the framework was to primary prevent a lack of management commitment and to also prevent lack of available finance. An analysis consisted by reviewing all of the elements of the framework that the people in the case study has actually been used. The validation of the framework in the case study work proved that the framework will work in different types of SMEs, low value high volume components and also low volume high value components. The outcome of the case study work has

proved that the work involved in the pilot study was of benefit to this research project in terms of obtaining important data from the literature review and also from the pilot study.

Finally, the structured interviews would provide some actual feedback from the people involved in the case study work. The analysis of the data arrived again that the design of the framework from this research project has been successful in obtaining the objectives set. Feedback from the users in the case study companies to remove the cause and effect CI technique is new and has not attempted previously. Also, merging the CI techniques of brainstorming, histogram and Five Whys will actually reduce the time and also the documentation required to achieve the root cause of a problem, and this is also a concept not seen previously.

3.15 Validation

The framework was used to conduct all data analysis of the problems identified by using histograms, brainstorming, Five Whys and cause and effect.

The validation process involved case study work on two companies. The format of the visits was mirrored to simulate a typical application process. The case studies consisted of 10 monthly visits of four hours' duration each. The first visit was to meet the top management and tour the plant. People within the process were identified who encountered typical problems. Case Study 1 involved a toolmaker and a machine setter, and Case Study 2 involved a wet paint sprayer and an assembly worker. The initial visit to the people was to review the framework and walk through the process. Identification of the problems followed that could be reduced. From discussions with the people involved in the case study work, it was soon evident that there were problems within the business. It was also noted at this stage that the management were aware of some CI techniques; however the people within the processes were not.

As there were people involved with the case study, the methodologies chosen would be of benefit to the research project – axiology for human effects and

ontology for systematically understanding or modelling, as well as using a combination of both qualitative and quantitative research methodologies.

Information obtained from the literature review of available CI techniques and barriers encountered was used for the basis of the interviews, which lasted about an hour with each person involved in the case studies.

Observations were conducted on a continual basis over the duration of the visits. The observations were focused on how the people involved in the case studies used the framework without any prior experience and, importantly, without any input from the research, the problems identified, the cost of the problems to the business, the problems processed using the framework and solutions to the problems.

The output of the case studies was successful; a meeting was held with the top management of both case study companies to propose the solutions to the problems that had been identified by the people involved in the case studies.

The management were very supportive and both companies were rather surprised that the problems that had been identified were such a high cost to both businesses.

3.15.1 Reliability and Validity of Data

Neumayer (2002) informs us that validity can be checked in examining whether cross-national differences in environmental attitudes are in accordance with theoretical hypotheses. The results in this research are encouraging and comforting, as they support the presumption of the validity of cross-national environmental survey data. The reliability of data can be affected by people's understanding of the data and their knowledge, although this will be dependent on the type of data being researched.

Koksal *et al.* (2014) found that their study resulted in reliability and validity values differing significantly across the data collection application. The differences may arise from differences in the data collections characteristics despite their having had some training; however, the finding regarding convergent validity supported the literature presented.

Pierannonzi *et al.* (2013) found in their research into reliability and validity of data that it continued to support the utility of data; however, more research is required to improve reliability and validity.

It is very important that the reliability and validity of data are accurate and precise. All five people who were involved with the questionnaires, case studies and interviews were asked to answer honestly. The researcher did not influence any of the people involved in this research.

3.15.2 Ethical Clearance

The questionnaire design took into account ethical considerations to ensure compliant with requirements of the University. The Ethics Committee at the University of Wolverhampton approved this study's questionnaire for the duration of the research project.

3.16 Summary

This research methodology section has identified established various methodologies that have been successfully used by authors. Axiology is used because humans are involved with the research and need to experience reality and make decisions; ontology to focus on the method of knowledge structuring and knowledge sharing. Epistemology is useful for the consideration of problems, attitude, method, activity, conclusion and effects. A literature review determines what barriers exist and identify available CI techniques. Qualitative research is helpful to explore social and behavioural needs and also to develop theories; quantitative research is applied to a sample as researched in the pilot study. Case studies serve to validate the framework and interviews to gain feedback from the case study work. The review conducted of such methodologies will support the process of obtaining data via postal questionnaires, structured interviews and case studies. These methodologies will be used later in this research to support the research to determine what is actually happening in manufacturing SMEs' waste minimisation processes and to support the development of a framework to minimise waste within a business.

Soft systems were reviewed, however the feedback from the literature review in Chapter 2, the pilot study and the case study was that this approach was too complex to review simultaneously all variables at once. Also, the people involved in the research found soft systems difficult to understand fully. After reviewing soft systems, it is therefore doubtful to include soft systems into the framework, it will later be reconsidered and a decision made.

Chapter 4: Framework Development

4.1 Introduction

It is important that CI techniques are used and that quality and improvement actions are a sequence of connected and logical activities that support the business (Capinetti, *et al.* 2003). Consideration in this research was also given to the following business improvement authors when developing the business improvement framework: (Castle, 1996; Jeong *et al.* 2001; Kaplan and Norton, 1992). It is important to consider the tools and also the users' skills to ensure the portal functions in meeting the needs of the users (Robinson, *et al.* 2011).

Whilst there are CI techniques and process models available, evidence has been collected that not all SMEs make use of them. Some SMEs are aware of such models and have had poor experiences of them. Also, if SMEs who are not familiar with such tools could encounter the problems that other SMEs have faced. The framework is being developed to ensure that the barriers identified can be counteracted for SMEs.

Chapter 4 focuses on the following thesis objective:

- Develop a conceptual framework which is user friendly and propose appropriate continuous improvement techniques and methods available to SMEs that could support them without the use of business professionals and prevent barriers.

4.1.1 Training Alone Will Not Improve Business Performance

Whilst companies will still have the training finance available and they will invest, there is still no guarantee that the CI programme will work, the danger of this quickly spreads and will prevent other business from implementing a CI programme. Other businesses just do not have the training finance available and therefore do not implement any form of CI programme. The framework developed in this research requires no training costs and the validation of the framework clearly demonstrates that it works.

Anderson *et al.* (1994) suggests training in the following methods: SPC, problem solving, decision making, team building, communication and leadership. In the US \$40 billion on average is spent a year on formal training. The most popular training is on SPC, 6 Sigma, design of experiments, and reliability; there is no mention of CI techniques in this vast spend on training.

Arnt (1992) promotes training courses in-company or on-the-job training, though it is important to note that experience in business projects is required to obtain specific knowledge of processes and products.

Bice (1989) recommends that lasting change is going to require patient and persistent education, more than just training in a classroom.

Bhulyan and Baghel (2005) use employee development activities to support training received in CI. Whilst CI programmes help to improve organisational operations in many aspects, they are not necessarily effective at solving issues. Companies have had to merge different CI programmes and have created a new CI programme called Lean 6 Sigma. The literature shows that there is no standard CI programme to form a CI basis and in general CI uses elements of TQM and Lean Manufacturing. This will require extensive training costs. In concluding there is little focus has been directed on a framework that would enable an organisation to identify the CI techniques that best suit them. The available courses are large CI programmes which require large training costs.

Baker *et al.* (2012) state that annually more organisations throughout the world utilise CI techniques to become more effective in their production methods. Yet, year after year, companies spend billions on training programmes, many of which fall short of their intended goals, creating even more problems for their businesses.

Lu and Betts (2010) point out that simply training people in CI technique will not necessarily provide success in a CI programme. In addition, a quarter of people who had been provided with training did not have the support of management, a barrier that needs a solution. There is also plenty of evidence to suggest that the training received is not up to the job it is expected to perform. Even after training had been received CI techniques had still not been implemented, so

training alone will not make change happen. A new framework would certainly be a positive move. Simply putting people on training courses will not work, as the knowledge and understanding of process improvement is required.

4.1.2 Knowledge Management

Training will not alone improve business performance; authors in this research state that KM is required to improve business performance and this is achieved from 'learning by doing'.

Martinus (2010) claims that training needs to be supported by connectivity of people to allow the flow of knowledge to progress, by industrial networks and also by diversity together with specific product and process knowledge to support business improvement.

Alrawi (2007) promotes a learning philosophy from within the business environment; it is suggested that more research should be conducted to determine how KM can be more effectively applied to organisations.

Ahmed *et al.* (2003) use knowledge learned from the business processes during the development of knowledge which can occur from learning by application and reviewing past work in order to improve.

Arona (2002) asserts that, rather than just learning from the basics, KM can avoid re-invention of the wheel in an organisation and can quickly benefit from the learning process and avoid making wrong decisions. This will also eliminate the problem of having few experts available. Communities of Practice will also support this process.

According to Guzman (2009), practical knowledge can only be learned from within the work environment. Practical knowledge can be defined as the ability to put previously acquired knowledge into effect in specific circumstances, this is achieved by know-how and learning by experimental work. Learning by doing and experimental work are required and the sharing of that knowledge is important, rather than just training. More research, however, is required in this subject.

Barber *et al.* (2006) state that even though CI techniques are available more research is required, because in their research in the north-west UK they found that only a few businesses actually used a systematic approach to business improvement.

Kean *et al.* (2007) claim that a driver is needed to promote knowledge transfer which encourages the users to seek and acquire knowledge from not only external sources but also internal business sources. This can promote a learning organisation where people can learn from experience together; training courses do not offer this type of knowledge. Again, further research in this field is still required.

4.1.3 Review of Business Improvement Models

Thi *et al.* (2011) have identified how businesses are often restricted by their current rules, which constrain business processes. Business rules are governed by policies, internal regulations, external regulations, events and organisational interactions. Reijers *et al.* (2009) have stressed that business improvement process models have been used in the past, but it appears that stakeholders face burdens with delivering improved performance. Business improvement process models should connect people in terms of communication; there is much more work to do in this area.

Dijkman *et al.* (2011) have pointed out that many organisations have repositories of business improvement process models, and such repositories may contain hundreds or even thousands of models, making them very complex for people to use effectively.

By the early 1980s, governmental and industrial leaders in the West were concerned by a lack of productivity, leading to a failure to compete in world markets. In the US, a national productivity study was commissioned, which gave guidelines on how to improve. Later on, in 1987, the Malcolm Baldrige National Quality Award was established. This was followed in Europe by the Foundation for Quality Management, the emphasis being on self-assessment and improvement planning. However, the European process was not seen as a

catalyst for inspiring nationally focused businesses, regional businesses or SMEs (Shergold and Reed, 1996).

From the knowledge learned over the last 50 years on business improvement, it ought to be clear that there are no magic solutions. Many of the quality gurus of the past, such as Crosby, Deming, Juran and Gryna, seem to have reverted to a common tendency when they advocated that there were 10 to 14 agenda items that had to be carried out. Just conforming was not enough to win in a dynamic environment (Castle, 1996).

In looking at a business, small processes can identify inputs and outputs and their relationship to each other. The next sub-sections explore other methods that have been published by academics for consideration for the framework.

4.1.4 Business Improvement Process Modelling

Carpinettii *et al.* (2003) suggest that through business process modelling, it is possible to map activities and their interrelationships, resources and organisational responsible for the activities, as well as the flow of information in terms of inputs and outputs in order to provide value to the customer. However, there is no information on how, if problems are found, they can be effectively resolved and prevented.

4.1.5 Business Excellence Model

Armitage (2002) states that SMEs have different characteristics in terms of culture, identity, function and customer response to their larger counterparts. In large organisations, the division of functions and labour, and the span of control considerations, result in the creation of a hierarchy of authority. Thus, there are several layers of management between the manager at the strategic apex and the operatives. This means that top managers in organisations are far removed from the point of delivery. Thus, they are likely to lack a deep understanding of operational issues, processes, customers' needs and quality issues unless they make a point to observe and experience the situation at the point of delivery. Research into the use of the business excellence model has not therefore been extensive in SMEs. This is due to the terminologies used. Armitage (2002)

asserts that a deep understanding is required of how resistance to change occurs and management barriers arise and thereby cause a lack of uptake.

Hewitt (1997) explains that the Business Excellence Model, shown in Figure 4.1, is based on gaining customer and people (employee) satisfaction and an impact on society, and is achieved through leadership driving policy and strategy, people management, and resources and processes, which should lead ultimately to excellence in business results. However, problems can arise when the following arise: a lack of understanding of the model, funding, not being focused on the big picture of improvement, a lack of time and a lack of training commitment.

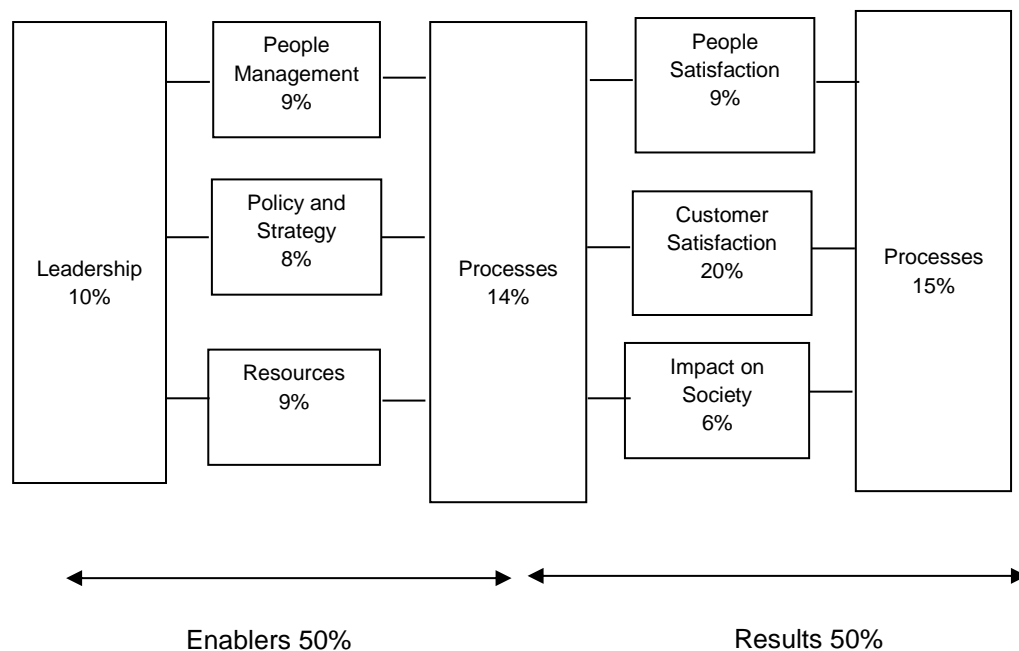


Figure 4.1: The business excellence model (Hewitt, 1997)

4.2 Total Quality Management

Castle (1996) seeks to pull together the efforts of organisation building and integration of human activities of many kinds. This means that management interventions intended to change the patterns of a system must be initiated at the primary level of the system, which can require many years to implement. A

company that does not carry out cost reductions fails to ensure the type of learning necessary to make managers and employees 'think constantly and creatively about the needs of the organisation'.

Using the TQM system as a process to improve a business is one of the most complex tasks that a business will encounter. It is not surprising, therefore, that there are more failures than successes. Common reasons are an absence or lack of attention, a failure to implement it, a TQM devised as an 'add-on', and high expectations of quick results (Thiagarajan and Zairi, 1997). For TQM to be effective, manipulation of the 'soft' must be supported by the 'hard' factors. 'Soft' and 'hard' factors are required to support the TQM system (Thiagarajan and Zairi, 1997), soft factors include:

- Senior management commitment
- Comprehensive policy and goal deployment
- Workforce commitment
- Active new roles for managers and supervision
- Empowerment
- Effective communication
- Internal customer supplier concept
- Teamwork
- A system for recognition
- Training and education

4.3 Integrated Quality System

Figure 4.2 shows Castle's (1996) model, which integrates a quality system by using intelligent activity, and the development of policies that encourage the evolution of motivation and learning in an activity seeking continual improvement. The model advocates that the organisation ought to understand its own current activity compared with the activities in the model. They may

decide that some are unnecessary, but that needs to be justified. ISO 9001 can be seen as a sub-system of this Integrated Quality System (IQS); this is also supported by Hewitt (1997), Lona *et al.* (2008) and Pilcher (1999).

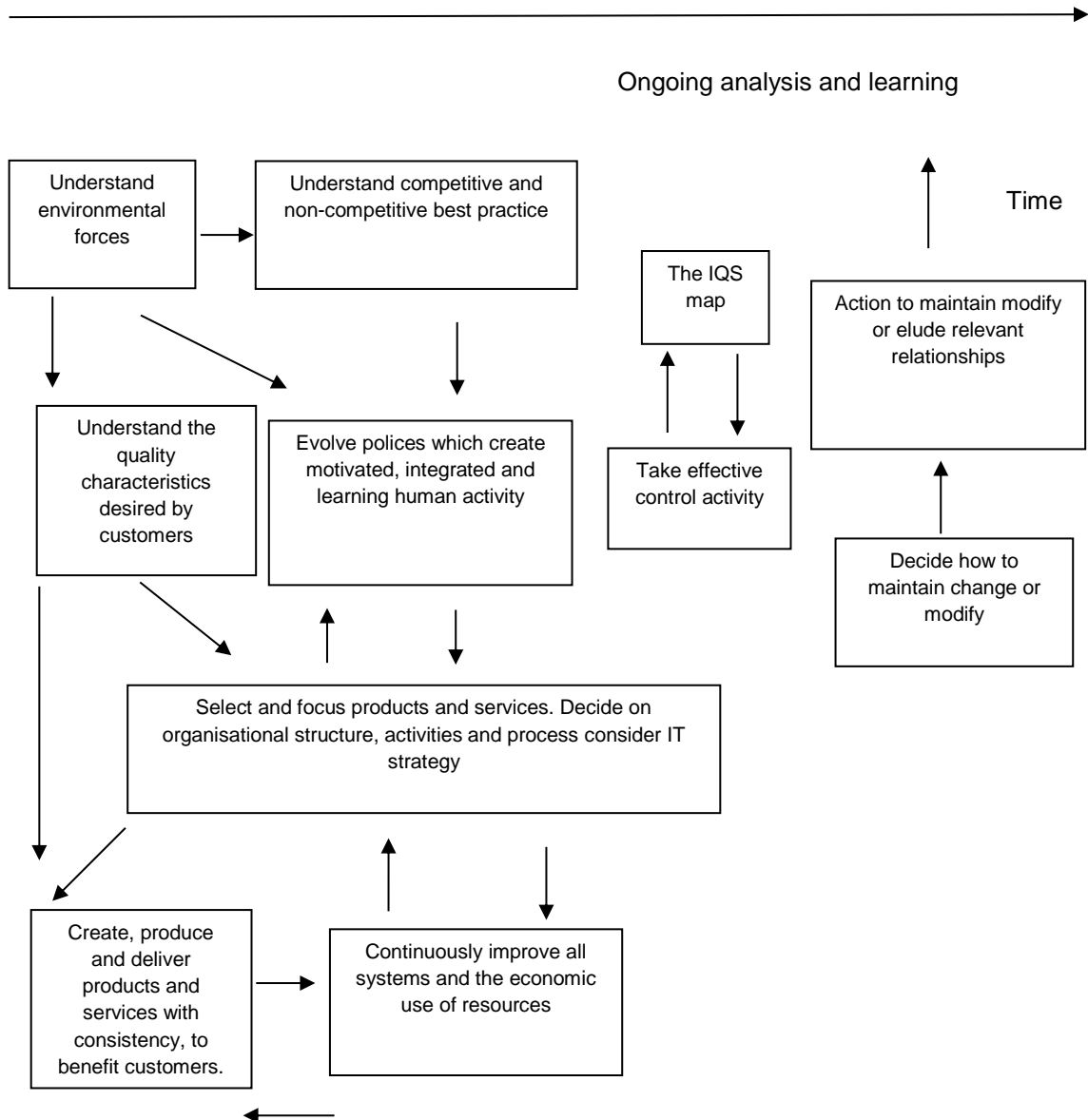


Figure 4.2: The integrated quality system based on an enhanced model (Castle, 1996)

Hard factors include benchmarking, performance measurement, management by fact, managing by processes, self-assessment, QC tools and techniques, cost of quality process, documented QMS, supplier management and customer management.

4.3.1 ISO 9001

Mulhaney *et al.* (2004) have noted that there is plenty of research published on the successful use of ISO 9001 within organisations, although these are mostly larger organisations where resources are available, leading to measurable improvements. SMEs do not have the resources to allocate one person to work full time to deliver improvements and change. Also, short-term expediency will always take priority over planning and implementing change. Such restraints in resources act as a barrier to SMEs seeking to change.

Coleman and Douglas (2003) have demonstrated in a study that companies that have implemented ISO 9001 were considered to akin to 'having quality', which is definitely not the case. The survey of over 600 companies from 20 countries found that implementing ISO 901 alone did not contribute much to quality improvements. Moreover, smaller companies were less likely to go further than getting ISO 9001 approval than larger ones.

4.3.2 Plan-Do-Check-Action

Lawrence (1983) uses a simple approach for making improvements:

- Define the problem
- Gather information
- Generate alternatives
- Evaluate alternatives/specify a solution
- Implement the solution
- Follow-up

Using knowledge to drive improvements looks simple when using PDCA, but the model's simplicity is deceptive. The fact is that most businesses do not have the discipline necessary to implement their improvement opportunities. They stop short of checking the feedback data and setting actions that could help drive improvement through the organisation (Matthews, 1996). This author promotes the use of Plan-Do-Knowledge-Act, which identifies opportunities in knowledge; this approach promotes the use of knowledge

that has been derived from information, and the approach can improved by training and experience over time. Harris (1994) also supports this concept, although there is more detail in the process model (see Figure 12). An important factor is the use of improvement teams supported by a management steering group.

Also supporting PDCA, as a systematic approach as defined in ISO 9001, are BSI, 2008; BSI, 2004; Straker, 1995; Zairi, 1999, and Fong and Antony, 2001. Mulhaney *et al.* (2004) support a top-down management approach using Plan-Do-Study-Act. Figure 4.3 shows a Plan-Do-Check-Do approach used by Harris (1994) to deliver business improvements throughout a business.

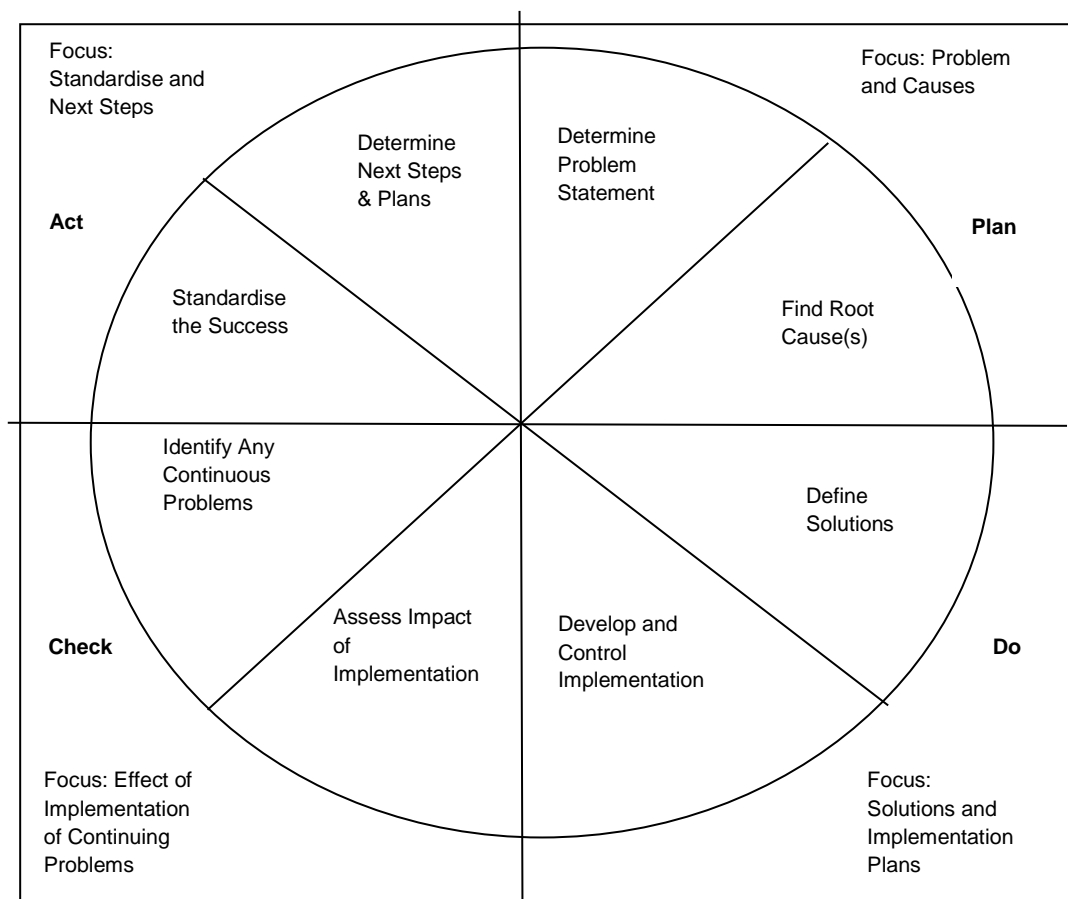


Figure 4.3: The Plan-Do-Check-Act matrix (Harris, 1994)

4.3.3 Four Key Process Approach

Jeong *et al.* (2006) promotes a four key process approach, which has an important bearing on addressing organisational level capability and maturity for process improvement:

1. Process definition: developing and sharing a common understanding of organisation-wide good practice processes
2. Process customisation: adopting and adapting good practice processes taking into account the specific context of individual projects
3. Process training: providing appropriate learning and dissemination mechanisms for all levels of employees to assimilate organisation-wide good practices
4. Process improvement resource: providing appropriate resources and support to foster process improvement and related organisational change

4.3.4 Balanced Scorecard

Dabhilkar and Lars Bentsson (2004) suggest many companies find it difficult to implement a systematic approach to CI that will bring a strategic focus to bear, which is a result of a lack of support caused by poor management commitment. Interviews conducted indicated a lack of understanding by management of the scorecards.

As devised by Kaplan and Norton (1992), Figure 4.4 shows the balanced scorecard, a strategic planning management system that can be used by a business. It offers a framework for performance measurement; however, it is not used by all SMEs due to management not implementing it:

- The learning and growth perspective: this includes employee training and corporate cultural attitudes; training metrics are put into place. Also mentoring and placing of tutors to improve the process of knowledge.
- The business process perspective: internal business processes are driven by customer requirement metrics, responsibility is with the management.

- The customer perspective: customer focus and satisfaction are indicators of whether the customer is not satisfied.
- The financial perspective: the use of data to measure the success of the business.
- Strategy mapping: used for communicating a story of how value is created for the organisation. It shows a step-by-step plan towards strategic objectives.

Kaplan and Norton (1992) promote the above key points.

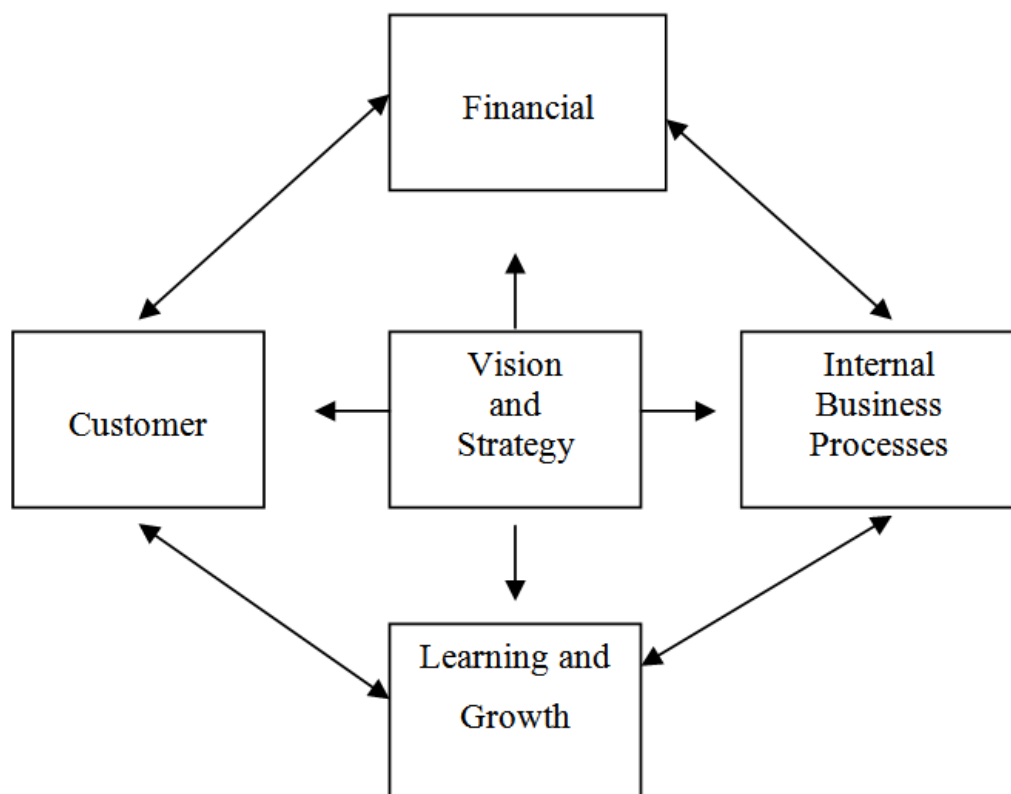


Figure 4.4: Balanced scorecard (Kaplan and Norton, 1992)

4.3.5 Six Sigma

Garza-Reyes (2010) has demonstrated how six sigma may be considered as one of the most important developments in quality management and process improvements. Formal training, process mapping and detailed company data

need to be collected, and many staff need to be engaged in six sigma projects. Issues still arise from management awareness, commitment and cultural change.

Bariaktarovic and Jecmenica (2011) have noted that management commitment and support is required to implement a statistically-based approach that is totally focused on customers and that contains various managers at different colour belts showing their expertise. These team of managers, experts in six sigma, are deployed to support the workforce to implement the process. Li (2014) has stated that particular six sigma knowledge is required for businesses to be successful, and six sigma knowledge should be strengthened.

4.3.6 Lean Thinking

Song and Liang (2011) have stated that while the construction industry is often associated with a conservative and change-resistant image, the acceptance of lean construction is also challenged. Lean thinking is new to many and to adopt it required extensive training. Another barrier to the adoption of lean concepts is the lack of effective implementation tools. The lack of acceptance may not be because of a lack of theories, but a lack of understanding of the implementation process and tools necessary to support the implementation. Song and Liang (2011) such tools include critical path analysis, databases and computerised applications.

Irajpour *et al.* (2014) explain that the tools and techniques of lean include TQM and Kaizen among others, and these also require expertise. The problems encountered have been discussed earlier in this section.

Schiele and McCue (2011) have noted how people must first be aware before lean is implemented in a business that it has limited applications to improve processes and then be willing to accept any changes that may be needed. They also need to understand that the number of lean tools that are applied are somewhat limited also. Several factors that can prevent a lean programme from being successful include: leadership styles, management support, buy-in of staff, understanding of processes and customer requirements, organisational culture, lack of clear customer focus, staff suffering from silo-effects and the

lack of systems thinking. Schiele and McCue (2011) additional research is required in the application of lean to make improvements within a business environment.

4.3.7 Baldrige Award

Table 4.1 shows a conceptual process integrating employee involvement and total quality management (EI/TQM) for performance improvement. The process appears to be quite complex; however, the principles may support the waste minimisation process. The main criteria here are management commitment and employee involvement.

Table 4.1: The Baldrige Award versus EI/TQM criteria (Pun and Gill, 2000)

Malcolm Baldrige National Quality Award	EI/TQM Implementation Model
Leadership	Senior executive leadership
Strategic planning	Strategic planning and alignment
Customer value and market force	Customer value and market focus
Information and analysis	Strategic information and analysis
Human resources focus	Human resources focus
Process management	Process analysis and management
Business results	Business results
	Employee satisfaction
	Supplier quality and relationship
	Environmental impact on society

Knowledge-sharing through networks can stimulate business improvement. This approach can also be supported by software-based applications. Lessons can be learnt from experiences within the business environment, and important knowledge can also be gained. This could be of use where waste minimisation projects have been planned within a business but there is no practical information, only a library of theoretical information (Perez-Araos *et al.*, 2007). It may be difficult for SMEs with no prior knowledge to implement a software

programme that contains links to an electronic library of popular CI techniques applications. However, such a system may be refined for use without prior experience of CI techniques.

4.4 Knowledge-based Process Models

Barber *et al.* (2006) have stated that knowledge-based support for waste minimisation does have a place; sharing knowledge across the organisation can lead to improvements to support initiatives. The process uses data to provide knowledge. The KMS allows direct access to data for solving problems and also provides data interrogation; once the problem is identified, the KMS will identify which tools can be used to help resolve the issues. There is more work to be done on KMS, and it requires further testing.

Business improvement process models can be associated with the performance of firms, which can provide value to manufacturing processes; however, they do not seem to guarantee higher performance, as demonstrated in the case of internet banks (Sahut *et al.*, 2013).

In considering the methods promoted in this chapter, it is important that they work for SMEs successfully.

4.5 Business Improvement Process Model Problems

Over the years, authors have promoted business improvement models, but they can be ill-defined and they require further research (Bhat and Rajashekhar, 2009; Hines and Rich, 1997). Many of the authors cited in the literature review define a method needed to improve and, by their own admission, such improvements require specialist support or extensive training. Most of the authors cited in the literature review use a case study approach and report on their findings, but it is not certain that these models are sustainable beyond the case studies concerned. Personal experience also demonstrates that

businesses that do not have specialists, time or resources for training for improvement projects are set to fail from the start.

4.6 Framework Specification

Key points to be addressed to ensure the success of the framework are: identifying waste activities, supporting change from the current state to the future state, not requiring business professionals, management being supportive with a written policy, generating interest, simplicity of use, workability, effectiveness, user-friendliness, use of facts and deliverability.

4.6.1 Potential Problem Areas

The perceived gap between the theory and the practice of waste minimisation techniques (Oduoza *et al.* 2008) and the barriers to adoption of good practice by SMEs (Smith *et al.* 2009) were considered in the development of the framework in this research project.

The literature review has identified that there may appear to be a barrier with senior management commitment, but it is important that this commitment is also at the middle and lower levels of management. It is therefore important for the success of the framework that the senior management team ensures this happens. It is suggested that the senior management team conducts a review process to ensure that the project maintains focus. In the development of this framework, it is important that improvements are sustainable.

4.7 Framework Development Considerations

Having reviewed many international publications, the following primary considerations have been developed to support business waste activity improvement in a simple way that will deliver waste minimisation for SMEs. It is therefore important that the following is considered for the framework.

4.7.1 Management Commitment

The whole management team needs to support the improvement programme and, most importantly, participate (McQuater *et al.*, 2000; Arvelo, 1995; Brice, 1989; Lawrence, 1983;; Ghadikolaee and Sini, 2008; Mulhaney *et al.* 2004).

4.7.2 Flowchart

This is needed for mapping out the business in terms of processes required to convert the input into the output. The process of mapping can provide simple information regarding the current state of a company (Hines *et al.*, 1998). Other authors who promote the use of flowcharts include Arndt (1992), Labanowski (1997), Oakland (2000) and Harris (1994).

4.7.3 Change Management

Understanding the importance of change to achieve improvements is critical, and the following authors promote this approach: Saka (2002), Trader-Leigh (2001), Lennox (1994), Bumes (2004), Proctor and Doukakis (2003), Kitchen and Daly (2002), Szamosi and Duxbury (2002) and Brown and Waterhouse (2003).

4.7.4 Communication

Effective communication is important to ensure project success and that problems are minimised. Authors and agencies that support this approach include BSI, 2008; TS 16949, 2009; BSI, 2004; QS 9000, 2000; Arndt (1992); Arvelo (1995); Anderson *et al.* (1994); Brice (1989); and Gertsen (2001).

4.7.5 Knowledge Management

The importance of learning by practice and experience can add value to a business and support improvement activities (Fernandes and Raja, 2002; Alrawi, 2007; Wadhwa and Madaan, 2007; Alrawi, 2007; Szejko, 2002). Knowledge management represents a deliberate and systematic approach to ensuring the full utilisation of the organisation's knowledge base (Han *et al.*, 2008). This type of approach can be applied to other areas of a business environment by the improvement of process effectiveness (Zhong *et al.*, 2003).

Problems can be solved faster, and the skills and competencies of the personnel can also be improved (Greiner *et al.*, 2007). This process is essential for translating individual knowledge into organisational knowledge. Thus, it is important to recognise that culture meaningfully influences the will to share knowledge within organisations. Issues that can affect cultural barriers are a lack of management support, incentives, social networks, job security and language barriers (Rivera-Vazquez *et al.*, 2009).

Checkland (1986) outlines how systems thinking is a methodology that looks at the whole environment of a situation that requires improving, rather than focusing on a particular point. Using this rather unpopular approach in the development of the framework will allow a view of the overall environment, which could support the identification of waste areas that could be improved. Using this approach is a way of tackling a problem that takes a broad view, all aspects being taken into account, and concentrating on interactions between the different parts of the problem to make progress.

4.7.6 Employee Competence

The success of improvement projects is often due to the use of champions who have training and experience, and this can make a real difference in improving businesses (Hall, 1993; Brice, 1989; Gertsen, 2001; Szendel and Tighe, 1994; Straker, 1995; Chester, 1994; Klink *et al.*, 2006). The framework that is being developed will develop employee competence over time; this is the justification for keeping CI techniques simple.

4.7.7 Plan-Do-Check-Act

This approach to continually solving problems by using a Plan-Do-Check-Act approach is supported by the likes of Matthews (1994), Fong and Antony (2001), Mulhaney *et al.* (2004), and Harris (1994). However, CI techniques are still required to drive solutions.

4.8 Framework Development

The original concept for the framework was to be based on VSM, but it was discovered that VSM alone would not achieve our research aim and objectives. This is also supported by the view that VSM is still an ill-defined toolkit and requires more research (Hines and Rich, 1997). Other authors have similar views, with some small successes being achieved, but all of which had professional support (Pavnasker and Gershenson, 2004; Voelkel and Chapman, 2003; ; Adra, 2004; Jones, Hines and Rich, 1997; Seth and Gupta, 2005; Chaneski, 2013).

4.8.1 KPIs Present State: KPIs Future State

BSI (2008), BSI (2004), Hines and Rich (1997) and all authors of CI and PDCA approaches promote the idea that before any improvement takes place, measurements should be taken. The reason for this is because, if there is no baseline measurement, how can improvements be demonstrated? The present and future states are critical in terms of waste minimisation and business improvement.

During the initial development of the framework, the possibility of using only KPIs was considered; however, following further research after the initial pilot study was sent, it was discovered that a histogram is essentially a graphical representation of a KPI, (Juran and Gryna, 1985). Therefore both KPIs and histograms were included in the framework.

4.8.2 Input – Process – Output

This is the conversion from input to output, which, in terms of a manufacturing process, would be raw material to a finished product or service. All businesses have inputs and outputs; these normally start with a customer enquiry and end with the supply of goods or services. When looked into in more detail, there are many inputs and outputs that support the overall input to output process of a business.

Administration functions are also processes; for example, a customer enquiry to customer quotation, a customer quotation to customer order, a customer order

to final specification, and so on throughout the entire business. This approach is supported by BSI, 2008; TS 16949, 2009; BSI, 2004; and Carwin (2000).

4.8.3 Process – Data

It is important to use data from the business processes; this can be used at a later date to support the quantification of improvements. The decision must be taken with regard to the type of measures taken and the frequency. Data collected from processes will form the basis for analysis and help support decisions to make any changes to minimise waste.

4.8.4 Change Process

The process of change from the current company state to the future state requires activation to provide the transformation. A decision has to be made to use quick and simple techniques. The change process can link activities of improvements for a business that will minimise waste. Authors that promote such techniques include Arndt (1992), Arvelo (1995, 1994), Murdoch, (1979), Mulhaney *et al.* (2004), Garcia-Lorenzo *et al.* (2000) and Juran and Gryna (1985).

4.8.5 Improvements

Improvements to the business will come about as a result of actions that change the business from its present state to an improved future state (Hines and Rich, 1997). It is important that improvements are quantified, sustainable and communicated to people in the business.

4.8.6 Auditing

SMEs do not have the resources to continually assess waste minimisation; therefore, an audit approach is the best solution to identifying opportunities for improvement. Conducting a real-time review of business processes to identify potential areas for improvement is the most suitable option. The audit uses the principles of the seven wastes (Hines and Rich, 1997) and carbon footprint principles (BSI, 2004). The auditing frequency should be in alignment with the available resources of the business, so it is suggested that it should be

repeated weekly. Actions will be required following any items discovered by the audit.

4.9 The Framework Flow Chart

The concept framework idea was based on the literature review of this research. A pilot study then followed to obtain feedback from 50 SMEs in the Midlands, UK, Odouza *et al.* (2008), The rest of the main study supports further development to result in a validated framework that actually works. Using a PDCA approach, waste is identified then monitored with the use of a KPI. The waste root cause is then identified, improvements made and the KPI is revisited to ensure that the process has improved. Figure 4.5 shows the flow of activities used to help develop the conceptual framework.

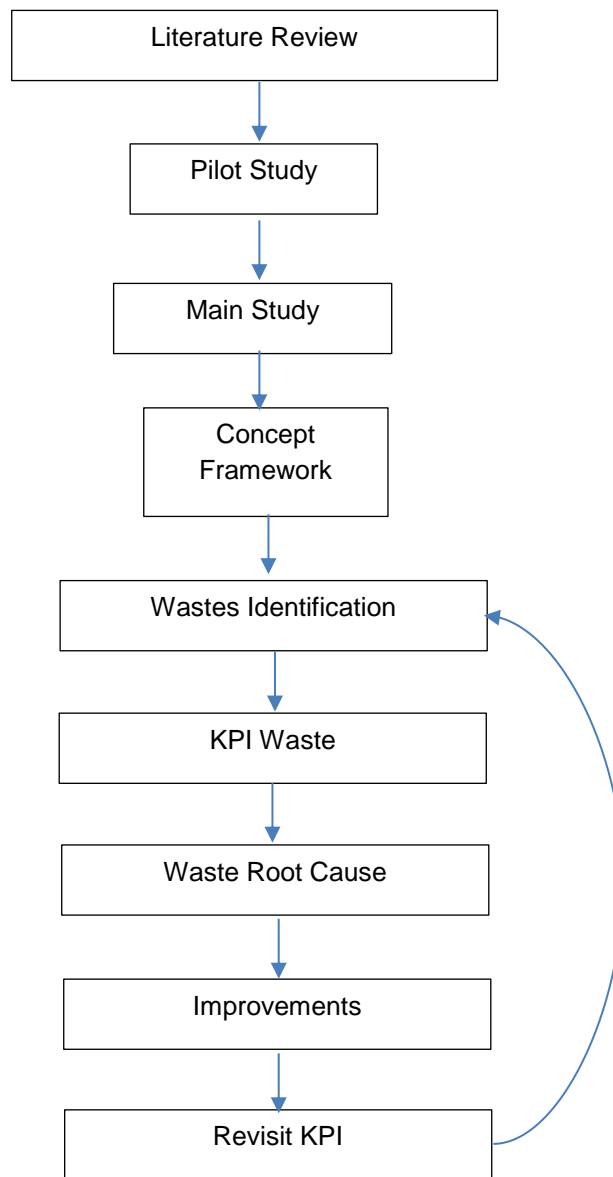


Figure 4.5: Flow of activities for developing the conceptual framework

4.10 The 4 Stage Continuous Improvement Framework

Figure 4.6 shows the pre-case study framework that was developed during this research. Smith *et al.* (2010) believe it is important for the framework to be quick to learn and easy to use. This is a framework that can be used to identify business problems and propose solutions to management for implementation. A four- stage approach was initially considered, which following case study work and structured interviews, may change for the final framework.

Stage 1 of the framework uses a business process which is to be considered for improvement (see Sample Process KPIs Format, Appendix 5), The business process could be, for example: administration, design, sales, purchasing, accounts or any of the manufacturing processes such as: milling, grinding, folding, laser cutting, drilling, welding or painting, etc.

Stage 2 consists of a Waste Prompt Sheet (Appendix 2) has been developed to support a Waste Identification Audit Sheet (Appendix 4) that will help guide people to focus on potential waste in the business. Examples of waste are specification errors, bills of material errors, excess packaging, supplier issues, and quality problems. Business KPIs in the form of a KPI Proposals (Appendix 3) are available to help identify possible areas of the business for improvement. The KPI can be used to demonstrate improvement from pre-process review to improvement after action implemented. Examples include late delivery, process downtime and quality first time pass rate.

Stage 3 supports people who have little or no prior experience, a PowerPoint presentation called 'Let's Improve' (Appendix 1a) has been developed to increase their knowledge by providing some practical examples. The presentation includes reference to overproduction, waiting, transport, work-in-progress, movement, unnecessary processing and defect product, (Hines and Rich, 1997). Stage 3 also supports improving knowledge of the CI techniques with a brief introduction to the following CI techniques: histograms (see Appendix 1b), brainstorming (Appendix 1c), Five Whys (Appendix 1d) and cause and effect (Appendix 1e). There are also some sample formats in the Appendices: histogram sample (Appendix 6), brainstorming (Appendix 7), Five

Whys (Appendix 8), cause and effect (Appendix 9) and ISO systems that can support root cause analysis and sustain improvements.

Stage 4 The framework core is a cycle of utilising a Project Sheet (Appendix 10) to record the problem and demonstrate actions that are required and by whom and when. The Project Sheet encompasses the Plan, Do, Check and Action (ISO 9001, 2008; TS 16949, 2008 and ISO 14001, 2004), which supports the co-ordination of any required actions to minimise waste. An Improvement Summary Sheet (Appendix 11) to demonstrate the successes that have been achieved in the business, will help to motivate people within the business to focus on the concept of the continual improvement philosophy (Oakland, 2000).

The framework core uses the approach of 'learning by doing' (Barber *et al.*, 2006). The exchange of experiences in the form of Communities of Practice will support the use of CI as a framework for improvement by teaching people to also learn from everyday experiences by working through networks (Retna and Ng, 2011). Communities of Practice supported by Knowledge Management will help demonstrate to SMEs the successes encountered using the framework (Riberio *et al.*, 2010). KM can also help facilitate better decision-making, increase profits and reduce costs (Chen and Chen, 2010). Knowledge will be gained of authors that have documented proven continuous improvement techniques. Proven successes will be stored in the Knowledge Hub of the framework. Simple PowerPoint presentations in the framework, on the topics of histograms, brainstorming, five whys, and cause and effect, contain simple and practical examples to support improvement (Appendices 1b, c, d and e). This kind of support is lacking in industry (Kelly, 2010).

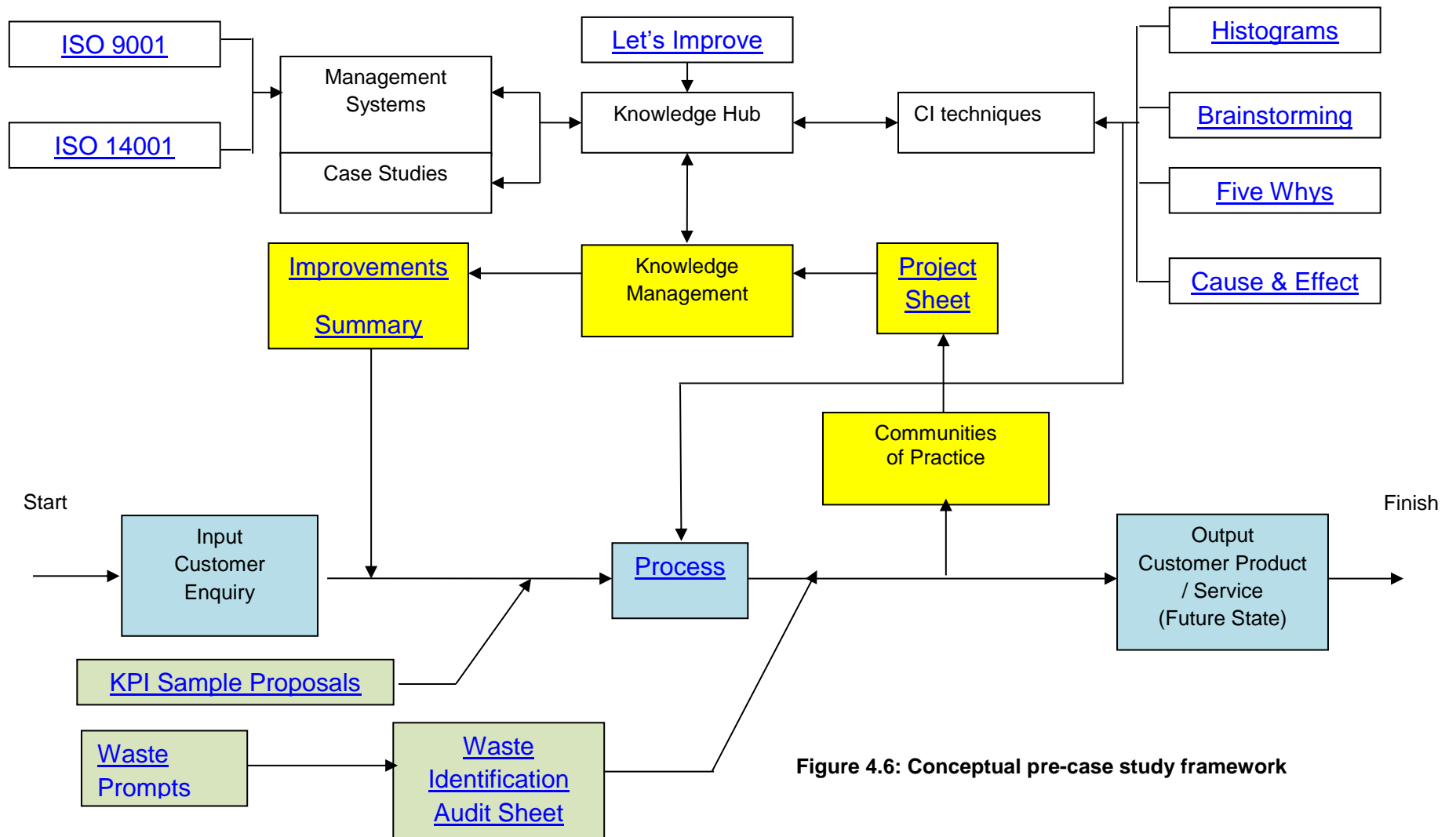


Figure 4.6: Conceptual pre-case study framework

4.11 Summary

Applying CI techniques research with a combination of a low uptake of CI techniques and barriers in SMEs results in the development of a framework to avoid the pitfalls of past researchers. A simple framework that delivers results should increase the uptake by SMEs where there is currently a gap in waste minimisation activities. Any identified improvements from using the framework will be forwarded to the management of businesses for consideration. The framework will later be validated in a case study environment of manufacturing SMEs to determine if the pitfalls of the past have been avoided. The next section of this research defines the type of methodology used to support the aims and objectives of this research.

Chapter 5: Continuous Improvement SME Awareness Pilot Study

5.1 Introduction

The continuous improvement SME awareness pilot study was conducted with 50 SMEs in the Midlands, UK, to obtain feedback from their awareness of business improvement. The information obtained from this survey would be used to support the development of the framework. To achieve a framework that would work in a business environment, it was important to ensure that the framework being developed in this research would be accepted and used by industry in an SME environment. Another important factor was that support from the top management would be achieved. A literature review was conducted in Chapter 2, and key elements were considered in the development of the continuous improvement SME awareness pilot study questionnaire. Questions asked in the pilot study included knowledge of Microsoft tools, ISO systems, use of professionals, actions taken to improve business performance, specific CI techniques used and knowledge of improving business performance.

Chapter 5 focuses on the following thesis objective from Chapter 1:

- Collect and analyse data of SMEs awareness of the continuous improvement technique and the barriers to it.

5.2 Continuous Improvement SME Pilot Study Design

The continuous improvement SME awareness pilot survey was designed to obtain sufficient data to support the conceptual process for the development of the framework. The pilot study questionnaire asked questions on common areas in the literature review and compared that to what is happening in industry. Also, it was most important to explore any lack of management, lack of resource barriers and any experiences or issues regarding why SMEs do not

implement CI techniques. An invitation to take part in the questionnaire was now extended to manufacturing SMEs.

5.3 The Continuous Improvement SME Awareness Pilot Study

SMEs business details were obtained from the Internet search directory Yell.com. All SMEs employ less than 100 people and are manufacturing SMEs based in the Midlands, UK, which is a highly populated region for SMEs. Postal pilot study questionnaires were sent, all of contained a self-addressed envelope for their awaited reply. The continuous improvement SME awareness pilot study questionnaire conducted was implemented in 2008, and 800 random SMEs were chosen. There was a response of 50 SMEs (6.25% response rate). All SMEs were given four weeks in October 2008 to respond. The SMEs that did not respond received a follow-up telephone call. All companies contacted by telephone showed an interest in improving their business. Respondents included steel components manufacturers, plastic components companies, electrical component manufacturers, pipework systems firms, CNC machined components companies, aerospace grinding companies and general mechanical engineering companies.

Ford and Bammer (2009) found that they received a 46% response rate to a postal survey, although this included reminders. In this research, a target of 50 replies; therefore, the number of surveys was increased to achieve this number. A decision was taken to only use a postal survey so as not to have any influence on the replies. Also, this would demonstrate any genuine interest on the part of the participants to improve their business. Sahlqvist *et al.* (2011) have stated that the postal survey technique is a relatively unobtrusive way to obtain information, although non-responses are common and there may be reluctance to disclose certain information. Typical response rates can be 17%. Harrison and Cock (2004) received a reply rate of 20% in their surveys, though lower responses are not uncommon.

A common practice in the researched papers is to conduct an analysis of the data received. Therefore, this was planned as the next step in this research.

The complete pilot study questionnaire can be found at Appendix 12.

Question 1 explored knowledge of basic computer skills within the business to determine the level of knowledge SMEs had of the Microsoft software, Word, Excel and Access. Figure 5.1 shows the response of the 50 respondents three were poor with Word, four were poor with Excel and 35 were poor with Access. Although knowledge of Access is not required, if the framework was to be developed in a Word and Excel format, it would be important that users had a basic understanding of this software. To cover all possibilities, the framework would therefore be developed in a pencil and paper format and also in a Word and Excel format. This would cover all possibilities.

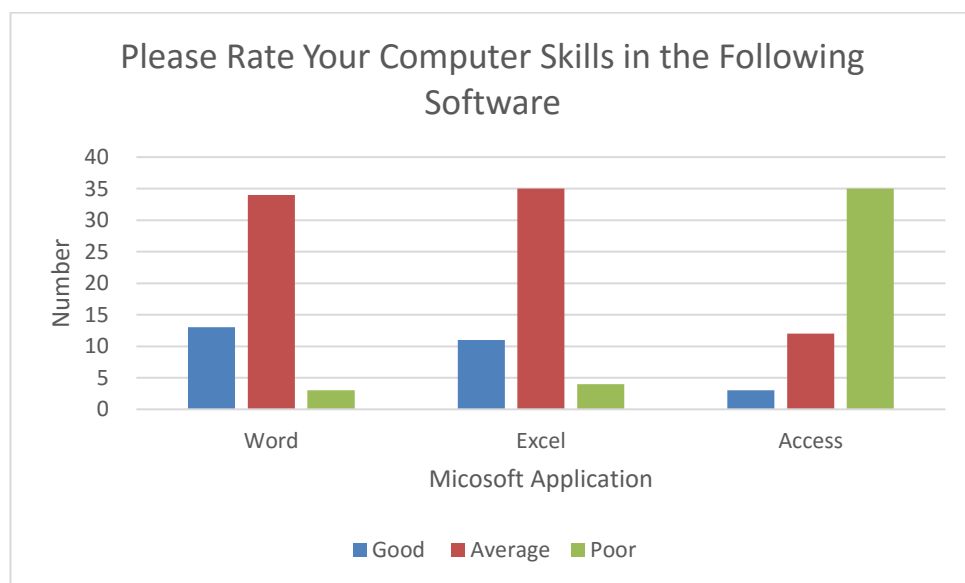


Figure 5.1: Respondents' knowledge of Word, Excel and Access

Question 2 sought to obtain data on the exposure to any formal ISO systems such as TS16949, ISO 9001 and ISO 14001. Figure 5.2 shows again the response from the 50 SMEs the detail of the technical knowledge of systems at SMEs. The concept framework being considered could be developed to ensure that it would be compatible with the skill levels within the business environment

it would be used. There are businesses that do not have any form of ISO systems knowledge so a low systems skill level framework would be required to ensure that the technical aspects of the framework were not difficult to use. There were five businesses certified to TS16949, six certified to ISO14001 and 35 certified to ISO 9001.

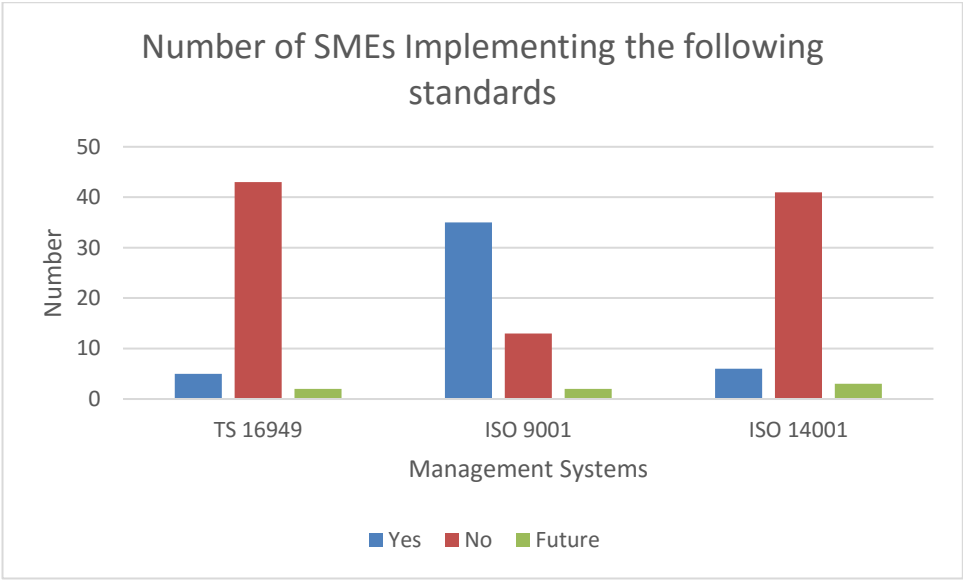


Figure 5.2: Quality standard systems implemented

Question 3 found that 26 of respondents employed business professionals. Of the 26 that employed business professionals, 16 were quality managers, five were consultants and two were quality engineers. A total of 24 of SMEs did not employ quality professionals; therefore, a framework would be necessary that would support SMEs that do not employ business professionals.

Question 4 sought to determine the level of knowledge of various practices that could affect the performance of a business. This question would test the knowledge of SMEs on their understanding of practices that could affect their business performance. The majority of SMEs from the data shown in Table 5.1 have an average understanding, whilst the SMEs that had only poor knowledge consisted of the following: 4, over production; 3, waiting; 3, transport; 1,

inappropriate processing; 2, unnecessary inventory; 6, unnecessary motion; and 3, defect. To accommodate all levels of knowledge, this response was considered in the framework design to ensure the framework covered all levels of practice that could affect business performance.

Table 5.1: Respondents' knowledge of practice that can affect business performance

Practice	Good	Average	Poor
Overproduction	15	31	4
Waiting	13	34	3
Transport	10	37	3
Inappropriate processing	15	34	1
Unnecessary inventory	14	34	2
Unnecessary motion	10	34	6
Defects	17	30	3

Question 5 sought to learn if SMEs measured production downtime. The response showed that 38 did not and only 12 did so. The response also showed that 27 measured a quality first-time pass rate and 23 did not implement any measures. This question provided information from SMEs about any typical KPIs that they may have in place that could affect their business. Therefore, it would be important that the framework would encourage the use of KPIs.

Question 6 asked SMEs if they were under pressure to improve efficiency. Forty-five that stated that they were and 5 said that they were not. If a framework was developed that could support business performance, it would therefore reduce the pressure on SMEs by improving their efficiency with increased business performance. SMEs were also asked to state the type of pressure they faced. The results showed various reasons why SMEs are under

pressure, and which are higher compared to those that were not under pressure. Such pressures included shareholders wanting a return on investment, customers wanting a prompt low cost product, legislation, competition and technological innovation, the results are shown in Figure 5.3.

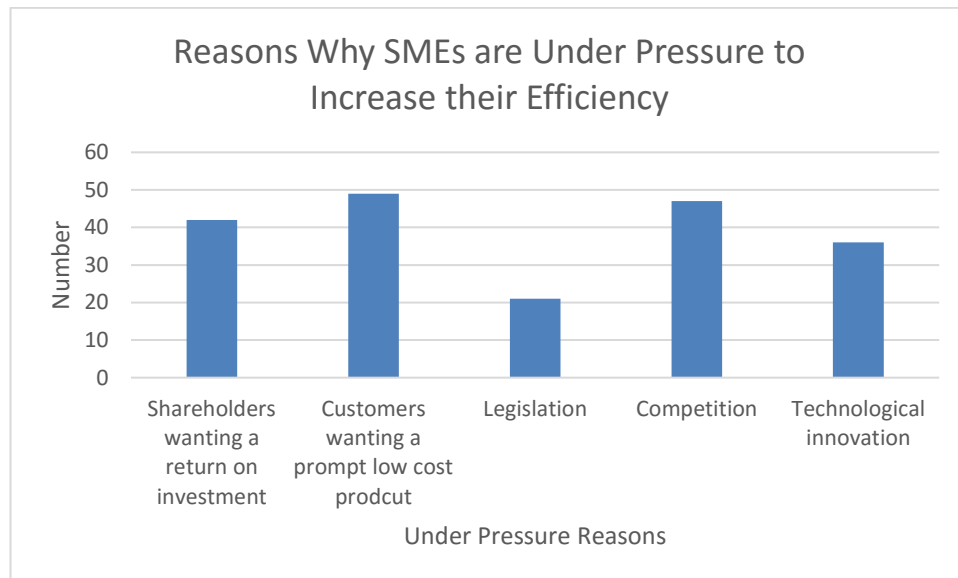


Figure 5.3: Typical reasons why SMEs are under pressure to improve efficiency

Question 7 was designed to understand the typical barriers that SMEs faced that prevented them from improving their business performance, in Figure 5.4. SMEs that faced a lack of goals amounted to 35; a lack of resources, 36; poor management commitment, 36; poor technical knowledge of processes, 29; and production pressure, 42. The reason that these form inadequate enablers of CI is due to the lack of a suitable framework that could support manufacturing SMEs to improve their business performance. This data confirmed the barriers identified by researchers that are documented in the literature review of this research project. Contacting the SMEs by telephone confirmed that if a framework could possibly achieve quick results and was low-cost, then there would be a commitment from the management. This re-iterates the need for a

framework and also the importance for such a framework actually working and helping SMEs improve their business performance.

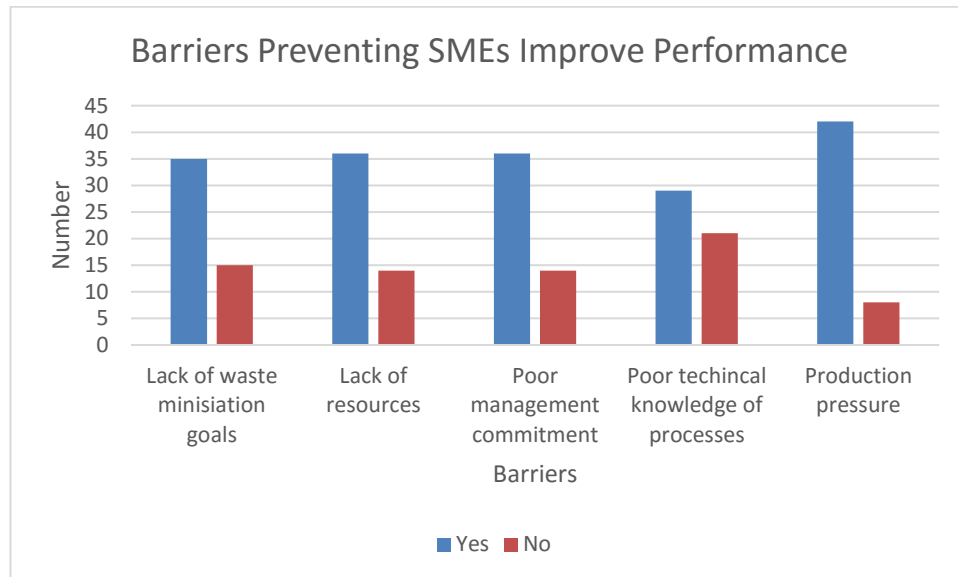


Figure 5.4: Barriers preventing SMEs from improving performance

Question 8 was aimed at determining whether SMEs used commonly promoted CI techniques, as documented by authors in the literature review section of this research project. SMEs have a need for such a framework based on their replies, as can be seen in Table 5.2. Categories of great interest that could benefit from the framework being developed in this research project are as follows: use sometimes, aware but don't use, and not familiar with the CI technique.

Table 5.2: Awareness of CI techniques used by SMEs

CI Technique	Used frequently	Use some times	Aware but don't use	Not familiar with technique
Cause & Effect	1	8	37	4
Pareto Analysis	3	7	31	9
Brainstorming	5	14	29	2
Tally Charts	2	10	32	6
Five whys	2	5	34	9
KPIs	5	6	27	12
VA/VE	3	6	30	11
Kaizen	0	3	35	12

Question 9 asked what other CI techniques had been used by SMEs. Their replies consisted of the following: 5S = 2, Balance Score Card = 1, Six Sigma = 2, TPM = 3, TQM = 4, CI = 1, and Kaizen = 2, however Kaizen had not been used frequently, according to the feedback provided in question 8. It can be concluded from this question that there is a range of SMEs that have a range of awareness with regard to CI technique awareness, however barriers do exist. This again confirms that there is a need for a suitable framework to support business improvement for SMEs that would increase the use of CI techniques and also counteract the barriers identified in published papers in this research. As documented in the Framework Development, Chapter 4, originally KPIs were only to be used, however following further research conducted in this research project it was discovered that histograms are used as a graphical representation for a KPI, therefore a histogram would also be included in the framework.

Question 10 requested SMEs' experience of using improvement techniques; there was no information forthcoming on this question.

Question 11 enquired about information regarding what could be done differently to help support their business to make use of CI techniques. The

replies consisted of the following: two SMEs requested additional funding, one SME asked for easier information access, and another asked for CI techniques to be easier to understand. Funding at the time of this research is now more difficult to obtain for this area, and even if it was available the barriers still exist that have been identified in this research; the same would also apply to easier access to CI techniques. With regard to CI techniques being easier to understand, the merging of certain CI techniques to make them more easily understood will be discussed later in this study.

Question 12 asked SMEs to list reasons for not improving the techniques that are shown in Figure 5.5. Data are as follows: complicated = 20, time restraint = 13, attitude = 4, cost = 3, and lack of awareness, lack of management commitment and not wanted = 1. If during the development of a framework, if it were not-complicated, it reduced the time to learn, was low cost and obtained management commitment, then this could reduce the risk of not improving, as indicated in the replies to question 12. If a new framework were easily available it could also change the attitude of people where they had encountered problems in the past from previous failed improvement projects. The replies in question 12 do indicate specific reasons, however these are in isolation to other activities such as: Knowledge Management, doing by learning and Communities of Practice. If the framework was not complicated to use, was quick to learn, was of a low cost and had examples of success, there would not be any potential barriers that could affect its implementation. A new framework developed later in this research provides guidance in the use of CI techniques with support activities such as: prompts, other user successes to learn from, etc. This would also reduce the barriers that have been identified. Also, merely simplifying CI techniques would not obtain the successes shown later in this research, as there would not be any learning from Knowledge Management and the application of a Communities of Practice approach in a learning organisation environment.

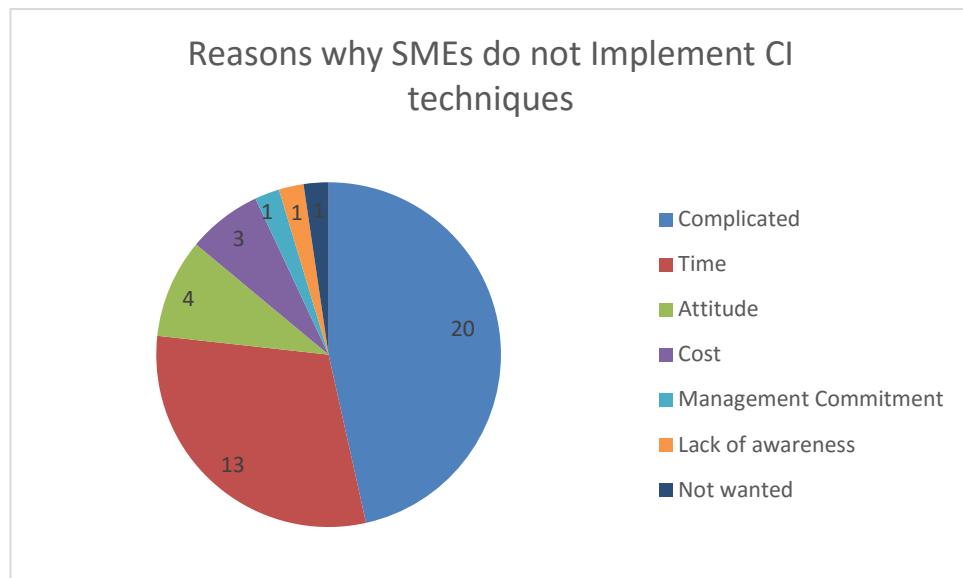


Figure 5.5: Reasons in numbers stating why SMEs do not implement CI techniques

For Question 13, there were 24 SMEs that wanted to know more about existing available CI techniques that could possibly help support their business in order to improve its performance. Once this research is completed, it is planned to approach these companies that have shown an interest in improving their business performance.

Question 14 asked about any typical benefits the 50 SMEs would expect from using CI techniques. The response of 40 replies was encouraging, in noting that some SMEs are aware of the benefits from the implementation of CI techniques, as shown in Figure 5.6. Therefore, if a suitable new framework was available, they would be certain to be interested in its implementation; this was confirmed by subsequent contact with each of the businesses that were aware of the potential benefits.

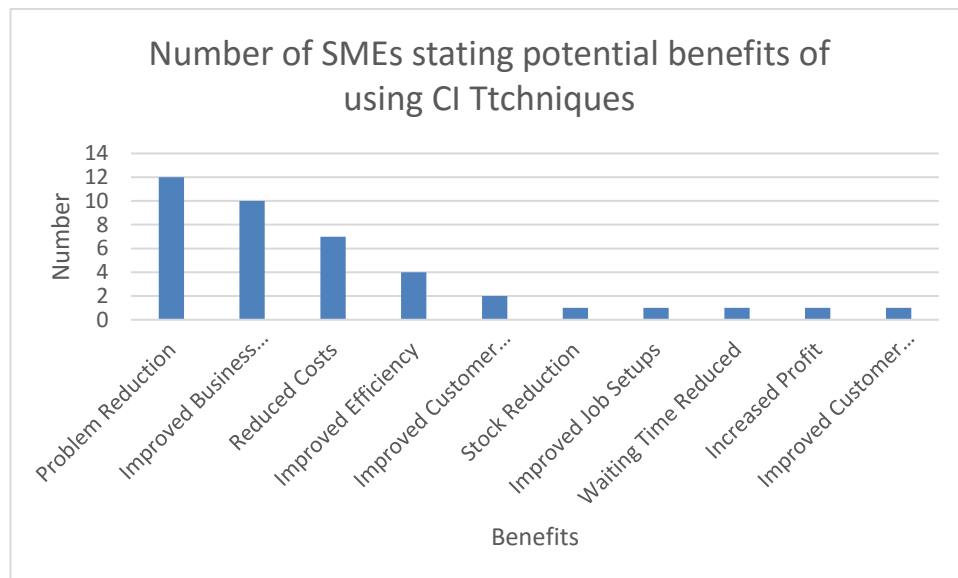


Figure 5.6: Number of SMEs stating potential benefits of using CI techniques

In relation to Question 15, it is interesting to note that only 11 SMEs stated on the pilot questionnaire that they would like to join a network. Yet, in the previous question, a greater degree of interest was expressed.

In relation to Question 16, there were 45 companies that did not object to further contact either by email or telephone.

Question 17 found that there was no additional information forthcoming from SMEs for ideas about a suitable framework, as documented on the pilot study questionnaire.

5.4 Continuous Improvement SME Awareness Pilot Study: Implications for the Main Study

The continuous improvement SME awareness pilot study obtained some valuable information on what actually happens in industry. Whilst there is some knowledge of potential CI benefits, there is a common theme that SMEs do not implement CI techniques. The information obtained from the continuous improvement SME awareness pilot study will be used to develop the framework

to satisfy the needs of SMEs to actually work in industry. The data obtained from the continuous improvement SME awareness pilot study will provide the parameters for the framework when developing it in terms of CI information, knowledge transfer, other cases studies to learn from, framework application process, samples of formats to work with and demonstrating savings.

5.5 Summary

The pilot study showed there is positive interest in a new framework that could benefit SMEs by reducing the current barriers preventing CI techniques from being used. Most importantly, a new framework could help SMEs to reduce the pressure they currently feel, which is due to various reasons. The framework should generate interest from a range of businesses that have shown interest and that have not been involved with the research project study. This will also strengthen the contribution to knowledge that is documented later in this research project. The case study will now be discussed.

The feedback obtained from the pilot study will be considered for use in the main study of this research project.

It is also evident that some SMEs wanted to know more about CI techniques, whilst others had had poor experience of such frameworks, as evidenced in the literature review in Chapter 2. Therefore, if a quick-to-use framework that used CI techniques was available, it would prevent possible difficulties for SMEs that want to know more about dealing with problems.

Chapter 6: Results from the Case Study Work and Structured Interviews

6.1 Introduction

This chapter outlines the case study SME companies' backgrounds and the processes that occurred in the case study work. The framework developed in this research was used by the case study companies to identify root causes for management action. Later in this chapter, a structured questionnaire is used to obtain feedback from key people within the businesses to check if the framework would solve the current problems and thereby improve business performance. Two companies were chosen as being very different businesses: Case Study 1 producing high-volume, low-cost components and Case Study 2, low-volume, high-cost components.

Senge (1997) promotes the Fifth Discipline, which demonstrates how to manage the success and development of a company and also how to create an organisation which excels. If companies are to survive they need to create a 'learning organisation' approach. Competition is fierce and, in order to create a learning organisation, five disciplines need to be implemented: Systems Thinking (which can be difficult and integrates the other four disciplines), mental models, team learning, personal mastery and shared vision.

Chapter 6 focuses on the following thesis objective from Chapter 1:

- Validate the developed framework in a case study environment focusing on business performance and thereby encourage continuous improvement uptake by manufacturing SMEs.

6.2 Case Study 1

Case Study 1 is based in Wiltshire and is part of a small group of businesses. They manufacture millions of small precision components for varied industries across the world, including the aerospace, automotive, defence, electrical, electronics, electron-mechanical, lighting and heating, hydraulic and pneumatic, interconnect, medical, nuclear, safety and security, sports and leisure, telecommunications and transport industries. The size of components varies from 0.3mm to 42mm in diameter. The company employs a total of 95 people, comprising management, skilled and semi-skilled staff.

Established as a Swiss watchmaker in 1940, the business has grown over the years to machining screws and fasteners. Most of the components contain turned parts, which are supported by design and technical expertise; the company is highly capable in launching products onto the world stage. Many successful products have been successfully introduced over the last 70 years of trading. Machines that are used to produce a high quality product to customers include 30 single spindle sliding head cam automatics, 22 multi-spindles, 65 rotary transfer, and 50 Computer Numerical Control sliding heads. The business satisfies the customer qualification process by being certified to the ISO 9001 Quality Management System and also any customer-specific requirements. The company is committed to: producing a profit, satisfying customer needs and generating a good quality reliable product, on time, at the right price.

Sales are co-ordinated from the head office, which is based in London. The sales team promote business from direct sales leads, the internet or repeat customer orders. The request is received by the company as an enquiry, and a drawing and samples is produced for the customer, using the prototype process. Once the customer is satisfied with the samples, a price will be submitted to them for consideration. When an order is received, this is acknowledged with the customer, confirming the specification, price, quantity and delivery date. Figure 6.1 illustrates the case study 1 process flow.

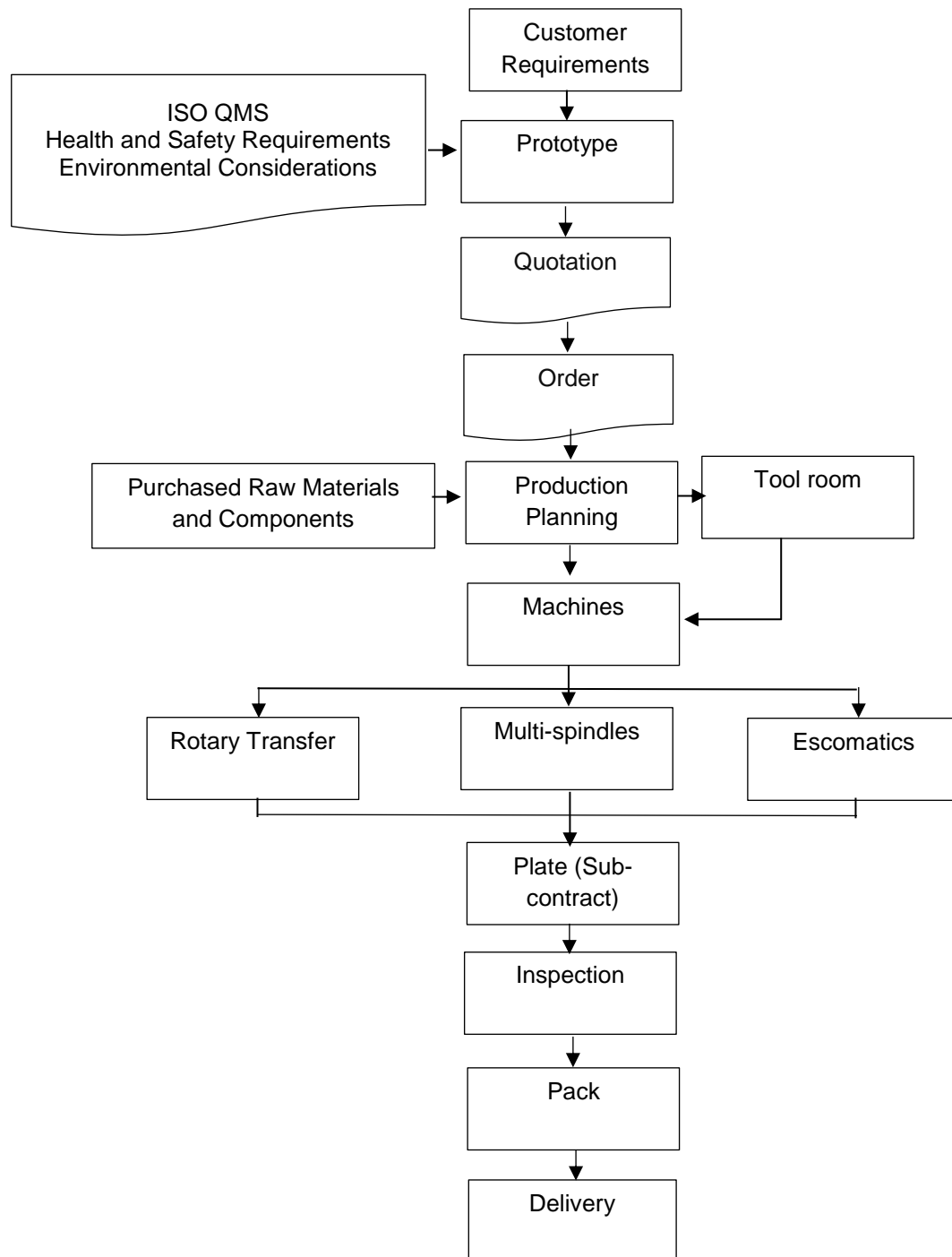


Figure 6.1: Case Study 1 process flow

Depending upon the type of product required by the customer, the required components are planned for the appropriate process. All relevant people are informed of the customer's requirements and the people resources are planned. If any special tooling or raw materials are required, they are ordered in anticipation of the customer's order.

The setter sets the machine using tooling supplied by the tool room and raw materials from the suppliers. Components are machined to the customer's specifications. All processes are compliant with the company's ISO 9001 quality management system. A first-off sample is produced and submitted to the quality department for approval. Providing the quality department pass the sample, the process is started and components are produced. Continuous samples are taken from the process and submitted to the quality department for continuous monitoring. Components that require additional external processing are sent to an appropriate approved supplier for further processing. When returned to the business, the components are sample audited by the quality department. Components are packed and palletised ready for delivery to the customer.

6.3 Case Study 2

Case Study 2, based in Birmingham, West Midlands, produces a range of lightweight, reusable, recyclable and strong aluminium containers. The company can also provide plastic containers, which are supplied by its United States sister company. Industries that it supplies include aircraft companies, the military and telecommunications companies. Business processes include: aluminium deep drawing, trimming, assembly, gluing and powder coating

In-house processes ensure that all products reach the customer at the right quality and at the right price. This is proved by the many repeat orders from customers who are pleased with the product and the service. In-house custom technical and design expertise and extensive product knowledge support all business activities in delivering high-quality products to meet client needs. Meeting customer needs also includes being focused on the concept of

available handling fixtures integral to the case for safe storage with easy access to fragile items, along with maximum shock and isolation protection to solve any shock or vibration requirements. The company's sister company in North Salt Lake, the US, provides cases made in plastic to support the UK customer base. The company's commitment to quality and the environment is demonstrated with the certification to ISO 9001. Figure 6.2 shows the process flow for Case Study 2.

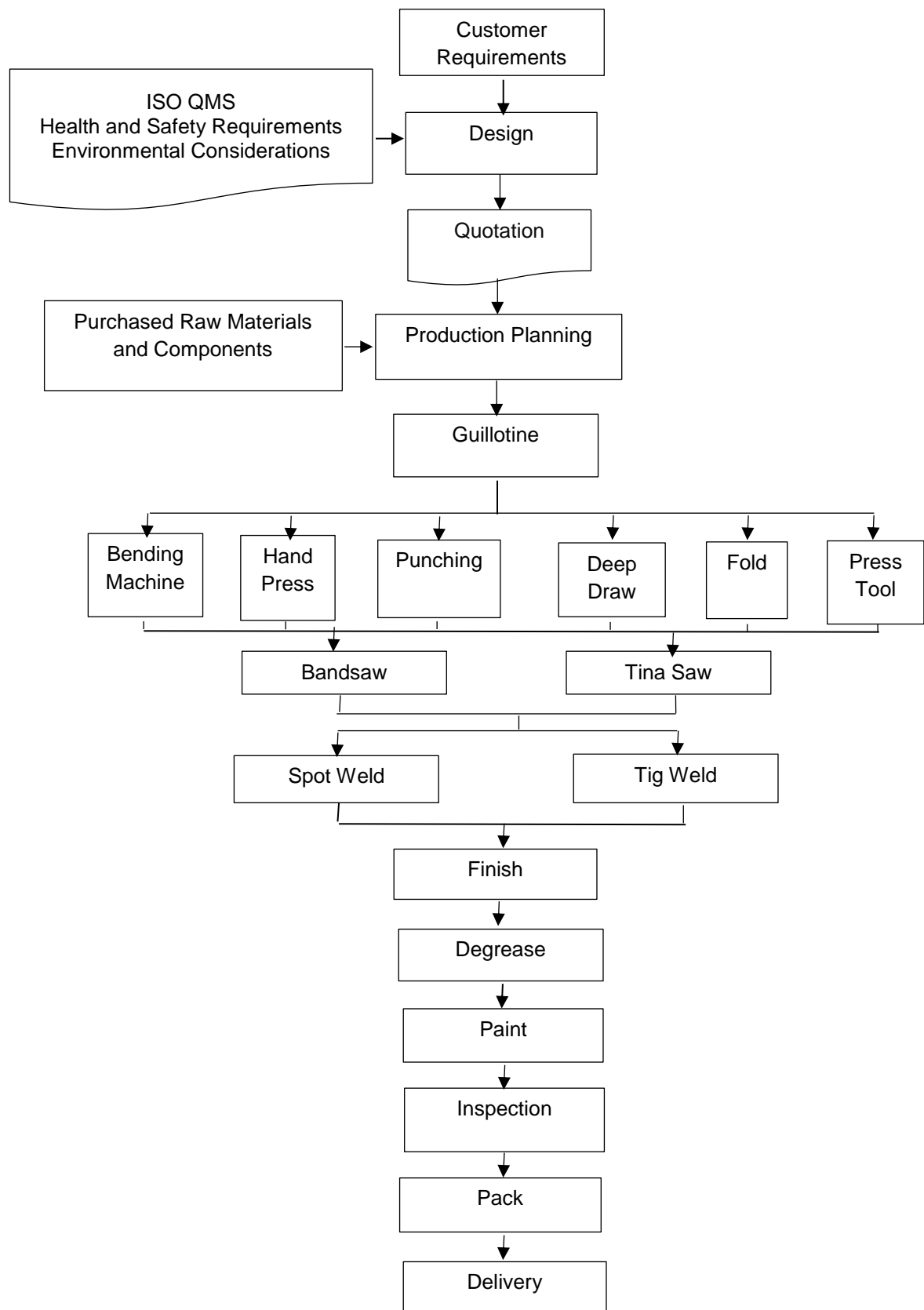


Figure 6.2: Case Study 2 process flow

Enquiries received are routed via the sales team, where a concept will be discussed with the design team, who will develop a concept design. The prospective customer will be invited to the business to discuss their requirements and to establish if the concept design will meet their requirements. If the customer requires any amendments, another meeting will be agreed to finalise the design. Once the design is agreed, a quotation will be sent and, if acceptable, an order will be received. The design, which also contains manufacturing drawings, will be given to the business planning department to organise the parts to be produced in house, and also to the suppliers. The ISO 9001 mark is used to control all business activities.

Production planning works closely with the sales function to process the order through the business to ensure that customer delivery dates are achieved. Production planning communicates their requirements through the supplier base in terms of raw materials and any specifics required to fulfil the customer's requirements. All planning allows for any specific supplier lead times, which are agreed prior to the contract being supplied. Production planning also informs the sales function of supplier lead times; this enables the sales team to communicate this to the customers, and an allowance is made so that it does not affect customer lead times. Once the planning is completed, the business lead time is set. When the order is received, the manufacturing processes begin. The production planning department reviews the production requirements and then informs the relevant process supervisors of the required processes required for manufacture. Processes can be a combination of guillotine, bending machine, hand press, punching, deep draw, fold, press tool, band saw, trina saw, spot weld, TIG weld, finish, degrease, and paint. On the satisfactory completion of all processes, the parts are inspected and packed ready for despatch to the customer.

Ten site visits were made to each case study company, consisting on average about four hours' duration. Each visit was held between April and September 2012, involving a site tour and meetings with key people within the

organisations from sales, purchasing, production, quality and despatch. Regular site visits also took place to understand and appreciate how the businesses operated. Case study work involved spending many hours with production and technical functions. From the first meeting, it was clear that there is a desire to improve but there were not the tools or techniques available on the shop floor of the businesses to make any impact on business improvement, and this was apparent for both case study companies. During the visits there were three meetings of one-hour-long duration held with the general managers of the case study companies, who explained that the business was keen to improve but they were not really aware that there were problems that could affect possible performance. It was clear from these meetings that the management had received past training had knowledge of CI techniques, systems and improvement projects such as Kaizen, CI, TQM and Six Sigma; however, such initiatives failed to deliver improvements due to attempting to implement complex improvement projects, there is a similar view from authors in the literature review in Chapter 2, in the form of barriers such as: financial restraints and management commitment. So purely implementing more training alone would not eliminate the barriers faced by SMEs. After discussions, the management of both businesses liked the framework when comparing other projects that they had used such as: Kaizen, CI, TQM and Six Sigma. The businesses had received visits from other institutes but without any success being recorded. Case Study 1 recorded problems, although no action was taken, and Case Study 2 did not. A project team was established for both case study companies to use the framework to improve business performance.

6.4 Case Study Teams

The sample size of participants involved from both case studies was a total of five people. The sample size was kept small so that more time could be devoted to detail rather than have more people involved who would have less detail within the time restraints of the case study work.

The case studies involved using the framework developed from the literature review in this research project. A small team was established which comprised a tool maker and a process setter from Case Study 1, and a paint sprayer and punching machine operator from Case Study 2. Neither had practical experience of using CI techniques to reduce business waste; the tool maker was aware of some basic CI techniques from some years ago; this was obtained from working with an automotive Original Equipment Manufacturer. However, these had not been used in at the business. The framework was presented in the office using a PowerPoint presentation to both case study companies. Both case study companies understood the concept and both were very keen to try it to reduce business waste. During the visits, the CI techniques in the framework were used and also a structured interview was implemented to obtain information from the case study work with regard to their experiences of using the framework.

6.5 Problems Identified at the Businesses

One common barrier identified that caused problems was that there was very little senior management commitment to preventing problems. It was also clear that there was real commitment to CI techniques that could be implemented in the business in order to improve business performance, even though the management of both case study companies had good knowledge of CI techniques.

Case Study 1 issues consisted of:

- Tooling: the process had stopped due to production tooling being broken or worn out, meaning there was no tooling available to manufacture components.
- Waiting for a setter: the process could not manufacture components because there was no setter available to set the machine to produce parts.

- Setting: there was a setter available and the machine was currently being set.
- Waiting to be set: the machine had just completed the last components of a batch and required setting for the next production run of manufactured components.
- Waiting for material: there was no material available; therefore, no components could be manufactured.
- Electrical: the process had broken down and was not producing components because of an electrical fault with the machine.
- Waiting for instruction: the machine was capable of producing components but the machine was not producing components because a specific instruction was pending from the management.

Case Study 2 issues consisted of:

- Manufacturing could not produce components because of a long lead time in drawings from the design department.
- Manufacturing could not produce components because of a long lead time in bills of materials from the design department.
- Components had to be part-sprayed and moved to complete the paint process because the paint booth was not large enough to powder coat components.
- Inconsistent paint thickness caused quality issues.
- Static shocks were causing a potential health and safety issue.
- There was a significant volume of powder coating paint waste due to the powder coating paint not being recycled.

- There were large holes in the curing oven that caused significant heat loss.
- Component damage was occurring because the jigging trolley was not strong enough to support the components during internal transport in the factory.
- Masking tape was being used once and then thrown away; this was result in a large bill from using masking tape that costs £25 per metre roll.

The research next reviewed the data that were collected from the case study companies.

6.6 Case Study Data Collection

This section uses the framework in a case study during the 10 visits of about four hours' duration each in the business environment to determine problems and the uses of selected CI techniques to suggest improvement actions for management which will improve business performance. The companies expressed interest in the concept of a framework that could help their businesses to improve their performance. No barriers were forthcoming from any people within either of the case study companies. Data was collected during several visits by the teams of the case study companies and recorded in the formats described in the framework. Data was also obtained from the case study companies during the validation process of identifying improvements that needed to be implemented by the management.

Firstly, the data are collected and published in the form of a KPI and shown graphically as a histogram. Each problem is brainstormed and for each possible variable, the 5 Whys process is conducted. It must be noted that the 'five' is a typical number of times to ask the question 'Why?' Some problems may require fewer or more 'Whys'.

Case Study 1 captured the process downtime used to quantify problems, although no actions were taken in the business. Case Study 2 did not collect any data in the form of shop-floor KPIs. A meeting of about one hour's duration was held with the management of both case study businesses to discuss the importance of data collection within the businesses. Following the meeting, both case study managements were keen to progress with the case study work.

6.7 Case Study Work

Following the presentation of the framework, both case study companies would use the framework to seek to identify root causes and proposals for the management of the case study companies to implement. The people involved in the case study work continued to explore root causes between the 10 visits made by the researcher.

The data collected in Case Study 1 were used as the basis for identifying problems that affect business performance. Using the framework was a good opportunity to use the data as a basis to drive some improvements. The framework was originally designed for a selection of CI techniques to be used, and it was discovered during the case study that the root cause could be achieved without the use of the cause and effect CI technique.

The case study work demonstrated in Case Study 1 that issues were continually recorded yet no action was taken by the business to minimise waste. The areas of concern that were raised were: tooling, waiting for setter, setting, waiting to be set, waiting for material and waiting for instructions. It should be noted that some of the issues, for example, waiting for setter, setting, and waiting to be set are similar concerns and will use the same five whys. Case study 2 worked well using the framework and there were no problems identified with its use. All of the people who used the framework were complimentary about the design and the application. The management of both case study companies were also very complimentary of the framework and both commented that they had eagerly awaited such a framework that could actually work for them.

6.8 Sample Case Study Process

The documentation developed for the framework was used. A sample of the information has been obtained from the framework formats, histograms, brainstorming and the five whys, and is shown below.

6.9 Histograms

Figure 6.3 shows a sample of weeks for the Esco process total hours downtime by week number. The high numbers justified the use of a framework that could identify opportunities of improvement for management action.

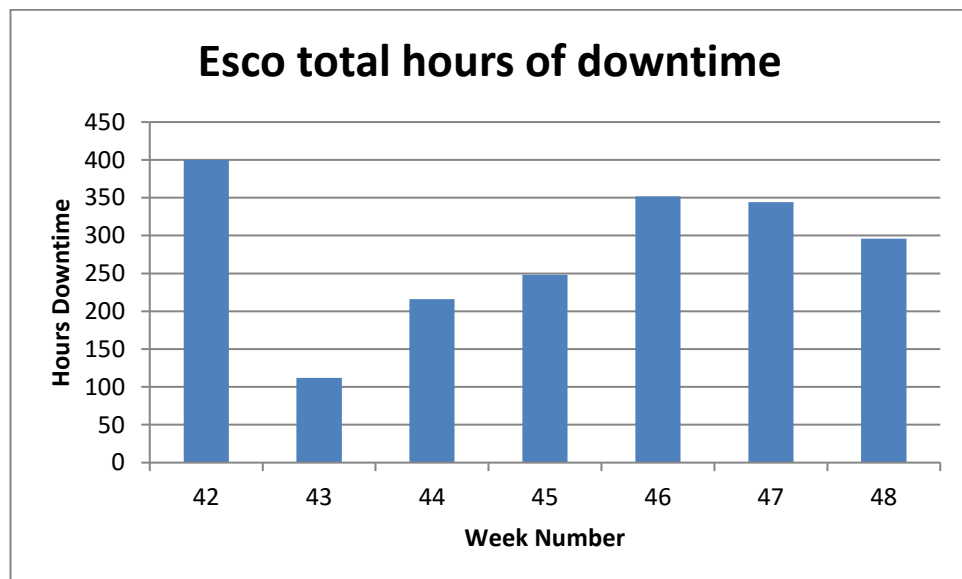


Figure 6.3: Esco total hours of downtime

Figure 6.4 shows the total hours of the multi-spindle downtime from weeks 42 to 48; again, these numbers could be improved if solutions using CI techniques were proposed to the management team of Case Study 1.

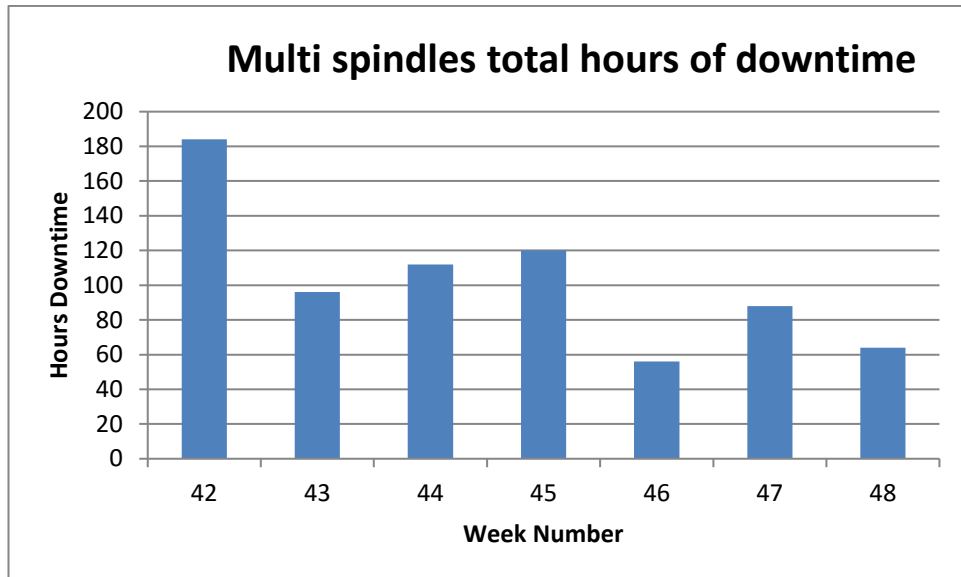


Figure 6.4: Multi-spindles total hours of downtime

Figure 6.5 shows a sample of a week's total downtime; week 48 has increased in comparison with weeks 42 to 47.

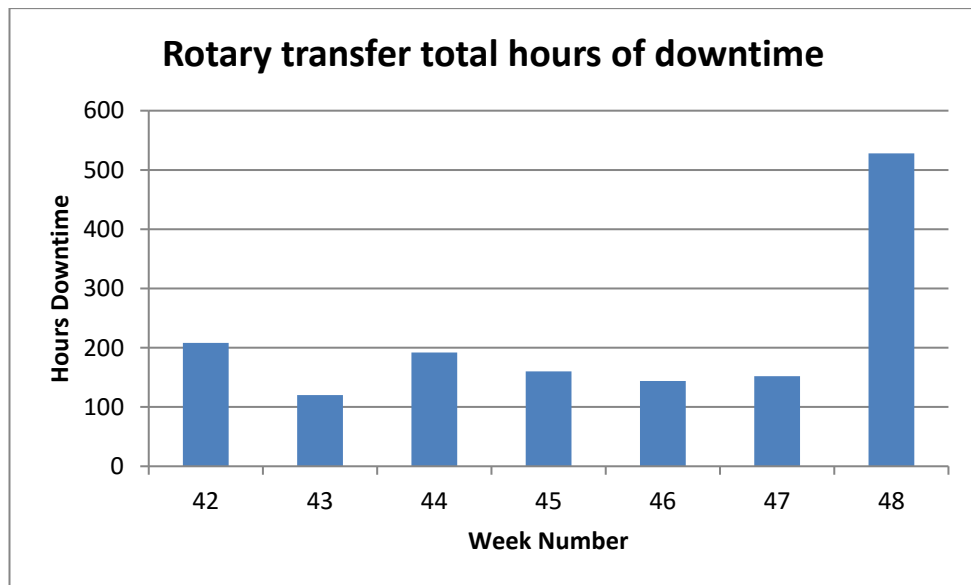


Figure 6.5: Rotary transfer total hours of downtime

6.10 Brainstorming

The CI technique of brainstorming was conducted for each of the issues identified. The brainstorming process is described in the framework (see also Appendix 7). Table 6.1 shows the ideas generated using the brainstorming process that could be applied to tooling that is broken or worn out. The toolmaker and the setter met in a quiet room away from the busy work environment to ensure they could focus on the issues. In this situation, there are seven possible solutions to the effect of tooling being broken or worn out.

Table 6.1: Brainstorming – tooling broken

Problem: Tooling broken or worn out Date: 28/11/2012 Team: Niall and Mick Generating ideas from a group meeting
1 / Speeds and feeds
2 / Manufacturing error tooling consistency
3 / Setting
4 / Run tooling to destruction
5 / Initial process set-up setting
6 / Material specification
7 / Tool design

6.11 Five Whys

To identify the root cause, the process of the 5 whys then has to be conducted for each of the seven possible contributions: speeds and feeds, manufacturing error tooling consistency, setting, run tooling to destruction, initial process set-up setting, materials specification, and tool design.

Table 6.2 shows the five whys process being used to identify solutions for speeds and feeds that can contribute to tooling being broken or worn out. Using

the five whys process, it seems that, if a procedure was in place and operators were trained in the procedures, this would prevent the issue arising.

Table 6.2: Five Whys – tooling broken, speeds and feeds

Problem: Tooling broken or worn out/speeds and feeds Date: 28/11/2012 Team: Niall and Mick	
Why	Set by experience
Why	Not defined
Why	No procedure in place
Why	No documented operator training matrix

In Table 6.3, it is clear that there are several issues with the tooling that can contribute to it becoming broken or worn out: incorrect clearance angles, incorrect tooling form, no standard format, and tooling is often based on the tool makers' experience, which can also be inconsistent. If a tooling standard was developed and implemented, this would prevent the problems associated with manufacturing tooling consistency arising.

Table 6.3: Five Whys – tooling broken, manufacturing tooling consistency

Problem: Tooling broken or worn out/manufacturing tooling consistency Date: 28/11/2012 Team: Niall and Mick	
Why	Incorrect clearance angles
Why	Incorrect tooling form
Why	Based on tool makers' experience
Why	Tooling inconsistency
Why	No tooling standard

In Figure 6.4 the same root causes have been discovered when investigating the setting process.

Table 6.4: Five Whys – tooling broken, setting

Problem: Tooling Broken or Worn Out/Setting	
Date: 28/11/2012	
Team: Niall and Mick	
Why	See setting

Table 6.5 shows an investigation into the root cause linked to running the tooling to destruction. If a tool life cycle management programme was in place, this would prevent the tooling breaking or wearing out, and this would reduce the process downtime associated with this issue.

Table 6.5: Five Whys – tooling broken, destruction

Problem: Tooling broken or worn out/run tooling to destruction	
Date: 28/11/2012	
Team: Niall and Mick	
Why	Always run tooling until it breaks in the process
Why	Operators not aware when to change tooling
Why	Accepted practice to run tooling until breaks
Why	No tool life programme determined

Again, Table 6.6 shows the same five whys as for the setting process.

Table 6.6: Five Whys – tooling broken, initial setting

Problem: Tooling broken or worn out/initial process setting	
Date: 28/11/2012	
Team: Niall and Mick	
Why	See setting

Table 6.7 identifies flawed and chilled materials, material variation and cheap poor quality material that had not been tested. If there was a material specification for the raw material with testing requirements, this would have prevented the issues encountered at the business with regard to tooling breaking or wearing out quickly as a result of material breakdown.

Table 6.7: Five Whys – tooling broken, material specification

Problem: Tooling broken or worn out/material specification	
Date: 28/11/2012	
Team: Niall and Mick	
Why	Flawed and chilled materials
Why	Material variation
Why	Cheap material
Why	Material not tested
Why	No specification for raw material or testing requirements

Table 6.8 illustrates how there is often a trial and error approach taken in the manufacture of tooling, compounded by a lack of tooling design. It was agreed that if there were a tooling design training programme implemented, this issue would be solved.

Table 6.8: Five Whys – tooling broken, design

Problem: Tooling broken or worn out/tooling design	
Date: 28/11/2012	
Team: Niall and Mick	
Why	Trial and error
Why	Lack of design-tooling skills
Why	No tool design training

6.12 Positive Case Study Feedback

The case study companies provided the following positive feedback:

- Quick to learn
- No difficult methods to learn
- Practical
- No outside assistance required
- Low cost
- Root causes easily identified for management action
- Quick to use

6.13 Case Study Tool Suggestions

The case study businesses suggested that the root causes were achieved by using only histograms, brainstorming and the 5 whys. Cause and effect was not necessarily used. The case study companies were invited to review the framework against other models that are available.

6.13.1 Framework Versus Other Models

During the case study, a comparison with other models were shown to people at the case study companies to determine if the design of the framework was an improvement on existing models. The comparison is shown in Table 6.9, which shows the strengths and weaknesses of the framework developed in this research compared to existing methods that are available. Based on the case study feedback, the framework is a preferred approach that can deliver root causes with minimal training, time and experience compared to the models that are currently available. The feedback also discovered that the framework is an ideal approach for smaller businesses; however, it could still be used in larger organisations.

Table 6.9: Framework versus other available process models

Model / Author	Weaknesses compared to framework	Strengths compared to framework
Plan, Do, Check, Action, Lawrence (1983)	Requires specialist support	None identified
Continuous Improvement, Arndt (1992)	Requires specialist support	None identified, does though use similar techniques
Kaizen, Chester (1994)	Requires specialist support, used for a limited time then fizzled out	None identified, does though use similar techniques
Integrated Quality System, Castle (1996)	Complex	May be more suitable where businesses have multiple ISO systems
Total Quality Management, Castle (1996)	Requires specialist support, used for a limited time then fizzled out	None identified
Value Stream Mapping, Hines and Rich (1997)	Difficult to understand, requires specialist support	None identified
Balridge Award, Pun and Gill (2000)	Requires specialist support	Possibly suited to large corporations
Business Excellence Model, Armitage (2002)	Difficult to understand, requires specialist support	Possibly suited to large corporations
Balanced Scorecard, Dabhikar and Lars Bentsson (2004)	Difficult to understand, requires specialist support	Possibly suited to large corporations
ISO 9001, Mulhaney (2004)	Requires specialist support	Helps to support a whole business simultaneously
Four Key Process Approach (2006)	Difficult to understand, requires specialist support	None identified
6 Sima Garza-Reyes (2010)	Requires specialist support, used for a limited time then fizzled out	None identified
Lean, Song and Liang (2011)	Requires specialist support, used for a limited time then fizzled out	Possibly suited to large corporations

6.14 Case Study Analysis

The use of CI techniques in an SME environment has been successful. Case Studies 1 and 2 are different manufacturing businesses in terms of low/high cost value and large, low-cost items. The case studies were completed successfully, and this has been evidenced by the researcher. The research aim was to reduce the gap in the uptake of CI techniques and also avoid improvement barriers. This was achieved by using a specifically developed framework, while using CI techniques to determine the root cause of the issues identified for management implementation. The previous figures have demonstrated this conclusively. Both case study businesses have a common theme in that they wanted to reduce waste and improve their business. To achieve this result, the development of the framework was critical to prevent past problems encountered by previous authors.

When preparing the framework for the case study work, it was important to prove the concept in a business where there are various high volume/low cost and low volume/high cost products being manufactured. There were many successes which provided some confidence prior to visiting the case study businesses. The first meetings were informative for all people as this involved learning more about the businesses and also the businesses learning more about the framework and how it could help the case study businesses improve. It was discovered in Case Study 1 that they were already using some data but there was no management action implemented. It was decided that, for Case Study 1, the problems already identified would be used. Case Study 2 was different as there were no measures and, in fact, they did not have any available resource to begin measuring. It was decided that a different approach would be used here. The audit process and meeting format were implemented.

Table 6.10 shows the problems that were measured in Case Study 1, which CI techniques were implemented to seek the root cause, which took 30 minutes each and the management actions required to solve the issues. The aim in the development of the framework was that it would be quick to use. It has also

achieved the objective of reducing the gap in uptake of CI techniques in an SME environment in seeking to minimise waste.

Table 6.10: Case Study 1 problems

Problem	Root Cause	Action for Management Implementation
Tooling: the process has stopped due to production tooling has broken or worn out and there is no tooling available to manufacture components.	No documented training matrix No tooling standard No tool life programme No specification for raw material or testing requirements No tool design training	Implement training matrix Develop a standard tooling format Develop a tool life programme Develop a specification and test requirements for raw materials Implement tool design training
Waiting for setter: the process cannot manufacture components because there is no setter available to set the machine to produce parts.	Busy with other work No setting cover for busy times	Increase setter resource during peak times
Setting: there is a setter available and the machine is currently being set.	See Waiting Setting	See Waiting Setting
Waiting to be set: the machine has just completed the last components of a batch and requires setting for the next production run of manufactured components.	See Waiting Setting	See Waiting Setting
Waiting Material: there is no material available therefore no components can be manufactured.	Supplier lead time not established People not trained in the reject procedure	Develop supplier lead time Train people in the reject procedure
Electrical: the process has broken down and is not producing components due to an electrical fault with the machine.	No electrician cover for peak times Seek possible obsolete parts	Additional electrician resource during peak times Seek possible alternative to obsolete parts
Waiting Instruction: the machine is capable of producing components but the machine is not producing components because a specific instruction is pending from the management.	Production plan not fully communicated	Communicate production plan

Unlike Case Study 1, Case Study 2 had no information available, which meant that the CI technique of a histogram could not be implemented. It was suggested, however, that the business was unable to provide sufficient resources to implement changes. It was also suggested that determining business waste could be ascertained by conducting a shop floor audit and speaking to people within the processes at the business.

Table 6.11 shows again the problems for which the CI techniques were used to determine the root cause and the action required by the management to solve the issue. It is interesting to note that the root causes in both Case Study 1 and Case Study 2 and the actions by management to implement changes are very similar. It is later planned to develop a website, and the two tables above would be excellent for promoting case study problems and showing the information through to management implementation. It is also planned to revisit both Case Study 1 and Case Study 2 to show the results; again, both tables would be excellent for communicating this. It is therefore important that both of the tables above support the objective of the framework and are simple to read and understand and require no further explanation.

Table 6.11: Case Study 2 problems

Problem	Root Cause	Action for Management Implementation
Manufacturing cannot produce components because of a long lead time of drawings from the design department.	Need to plan work more effectively Not enough designers and need to learn from mistakes	Review existing workload and plan more effectively Review level of designing resource increase at peak times
Manufacturing cannot produce components because of a long lead time of bills of materials from the design department.	Same as drawings	Same as drawings
Components have to be part-sprayed and moved to complete the paint process because the paint booth not large enough to powder coat components.	Spray booth is not large enough	Feasibility for larger spray booth
Inconsistent paint thickness causes quality issues.	No defined spray pattern	Define spray pattern
Static shocks are causing a potential health and safety issue.	Review static strap condition and current procedure	Review static strap condition and current procedure
There is a significant volume of powder coating paint waste due to the powder coating paint is not being recycled.	Review maintenance training	Review maintenance training
There are large holes in the curing oven that cause significant heat loss.	Operators not trained in maintenance	Train operators in maintenance
Component damage is occurring because the jiggling trolley is not strong enough to support the components during internal transport in the factory.	Jigging trolley not suitable for large components	Design and manufacture a jiggling trolley that will accommodate large product
Masking tape is currently used once and then thrown away; this is resulting in a large cost from using masking tape that is £25 per metre roll.	Look for a masking shield that could be used many times	Look for a masking shield that could be used many times
Poor tooling condition.	There is no procedure for tooling maintenance	Develop a tooling procedure for tooling maintenance

6.14.1 Structured Interview Analysis

A structured interview was designed and developed to obtain data from people involved in the case study businesses. The questions were designed to explore aspects that could cause a barrier to the case study. The objective of a structured interview is to obtain data to provide information to assess the suitability of the framework for industry. The questions in the structured interview were short and many simply required a 'yes/no' answer. The structured interview was also designed to encourage any additional comments from the case study. The complete questions of the structured interview can be found in Appendix 13.

The total number of interviews included all people that were directly involved in the twocase studies, a total of 5. There were 3 from Case Study 1 and 2 from Case Study 2. The small sample size of 5 in this research was then compared against other authors' use of low sample sizes: Karadag (2013) identified typical sampling methods, which include: simple random sampling, stratified sampling, purposeful sampling, cluster sampling, maximum variation sampling, criterion sampling, critical sampling, systematic sampling, extreme case sampling, convenience sampling and snowball sampling. Karadag (2010) promotes the most common 62.1% used as a simple random sampling solution, due to the fact that you cannot study the whole universe at once, but a sample can represent part of the larger population. Laurretto *et al.*, (2012) promote the Intentional Sample by Goal Optimisation approach. Intentional sampling methods are intended for exploratory research or pilot studies where tight budgets exist. Intentional sampling methods are non-randomised procedures that select a group of individuals for a sample with the purpose of meeting the criteria.

Figure 6.6 shows 5 people's responses that companies had a good to average understanding of MS Word and Excel. Three people did not have any experience of MS Access. Even for people who are not experienced with either MS Word or MS Excel, a paper and pencil version could easily be used and could provide similar results.

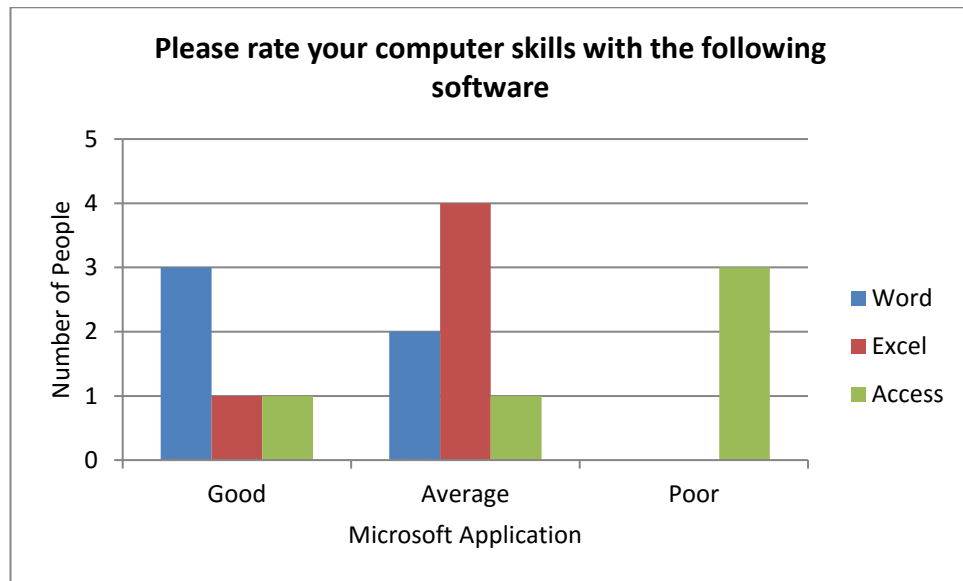


Figure 6.6: Software computer skills

Figure 6.7 shows five people in the two case studies who had experience of ISO 9001 systems and five people who did not have experience of TS16949. Four people had experience of ISO 14001 and three people had experience of PDCA; two people possibly will have in the future. Three people did not have experience of the business excellence model and two possibly will have in the future. Three had experience of knowledge-based systems and two do not. Four had knowledge of the balanced score card and one might possibly have in the future. This demonstrates that there was a base knowledge of systems within the case study companies.

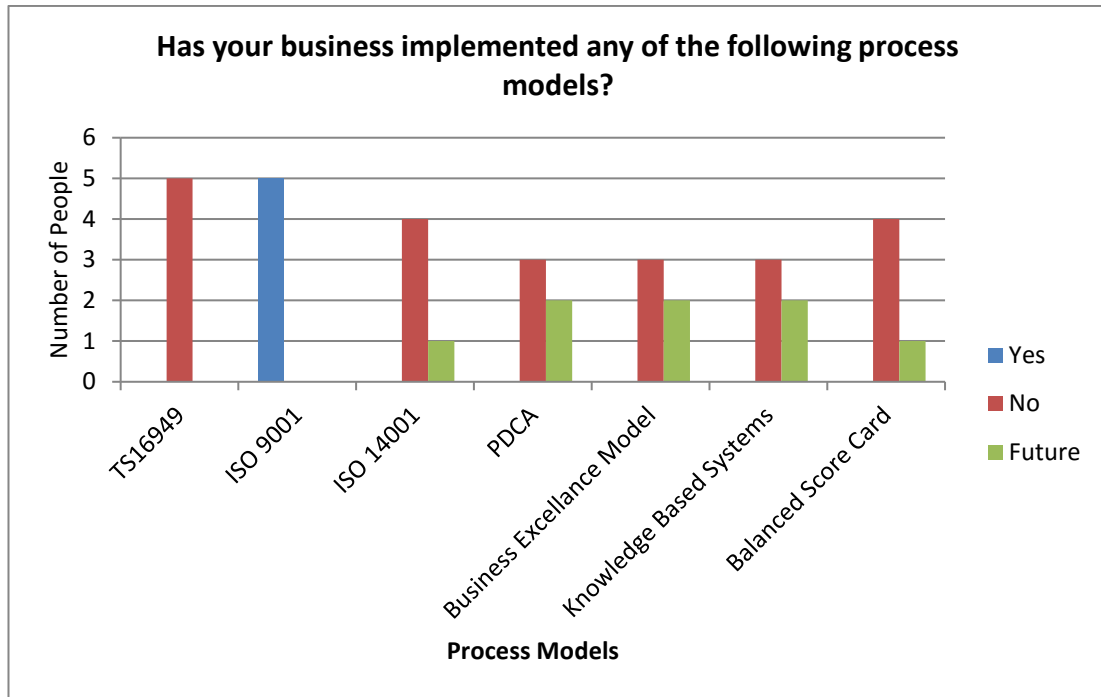


Figure 6.7: Businesses that have implemented process models

No one listed other process models. However, when asked if they had heard of Kaizen, TQM, Six Sigma and CI, they all had heard of them.

From the case study, no-one interviewed could identify any strengths or weaknesses that another process model could provide.

All the interviewed people confirmed that the top management would support any projects that would improve the business. As noted by authors in the literature review, this is critical to any improvement project's success: lack of management commitment has been defined as a barrier to improvement projects.

When asked if the business was under pressure to improve, 4 agreed, and this was due to their customers demanding quick lead times from the business. This confirms what authors are reporting in academic papers. If a framework was to support a business to reduce this pressure where previous process models have failed, the framework would be a good success.

All five people stated that their businesses did not use a business professional to implement business improvements. This may be of benefit when using the framework, as the framework has been designed and developed specifically for businesses that do not employ business professionals for this purpose.

The interviews revealed that three people had not received any formal training in CI techniques and two had received some form of CI techniques training. The framework was developed for people with minimal experience of a framework, therefore people in the case studies with little experience will prove the view that the framework is simple to use for people with limited experience. This will also be balanced by people who have had experiences.

Figure 6.8 shows that process downtime and defects were the two most popular KPIs in the case studies. There were some limited KPIs in the case study businesses. Case Study 1 was recording issues in the form of quantified data and Case Study 2 did not have any measures implemented. The framework was developed to prompt the use of KPIs and also identifies some examples that could support a business.

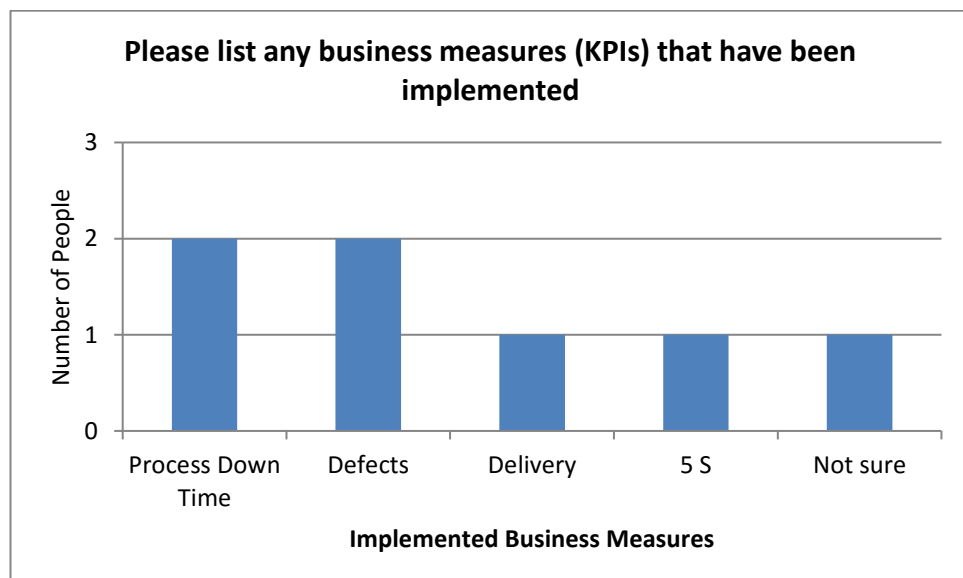


Figure 6.8: Implemented KPIs in case study companies

The majority of people stated that there was a person in the organisation who had some knowledge and experience of CI techniques. However, it must be noted that these skills were not used to implement any improvement projects in the case study companies.

If a problem had to be solved, people answering this question agreed that either a team discussion should ensue or the manager should be spoken to. Others when prompted stated that they were not sure. A team discussion is a popular choice as this is the start of a good foundation when brainstorming is implemented which, to be successful, consists of people working together as a team.

People thought using scrap parts was waste minimisation; this was closely followed by other stating that they were not sure. It is therefore evident that there is a lack of knowledge on the reasons for problems arising on the part of the people interviewed.

When asked what their perception of business improvement was, two people replied that they were not sure, whilst all other answers were divided between motivation, efficiency and the need to reduce scrap. The framework would therefore contain examples of such improvement concepts in order to support this area.

With regard to reducing scrap, two people were unsure and other single answers ranged from suggestions about reviewing raw material usage, team discussion and looking at scrap. Again, the framework contains prompts of particular areas where a business can identify particular specific wastes.

Figure 6.9 shows that the principal answer was that over-production was the main waste minimisation practice, closely followed by suggesting unnecessary inventory and defects. Other answers were evenly spread, with the average being that there was unnecessary inventory and defects. No-one stated that they were poor with regard to the above subjects. This confirms that there is some base knowledge. The framework being used will develop this knowledge further as experience is gained of using the framework.



Figure 6.9: Knowledge of waste minimisation practices

When people were asked what CI techniques meant to them, they all answered that they were not sure. Working with the CI techniques in the framework such as: histograms, brainstorming and five whys has increased their knowledge.

Figure 6.10 shows that there were three people in the case study companies who used a quality first-time pass rate; two were unsure. The rest of the results were evenly spread, as shown in the chart. Speaking to the people after using the framework, their understanding of waste minimisation has now improved from their original answers in the structured interviews.



Figure 6.10: Use of waste minimisation practices

When people were asked of the terminology 'CI techniques' meant to them, they all answered that they were not sure. Whilst people in the survey were aware of the different types of CI techniques, such as histograms, brainstorming and the five whys, their level of knowledge had increased. The respondents' understanding of the terminology of CI techniques and how it is used to group specific techniques together, such as: histograms, brainstorming and the Five Whys.

Table 6.12 presents several questions with regard to potential barriers. All the questions were carefully designed from notes made from the literature review. Each of the questions was aimed at preventing a problem arising during the use of the framework in the case study work and later in industry. This ranged from ensuring that goals were defined with KPIs through to everyone being committed, especially the top management. Ensuring that the pressures businesses face are reduced, as a result of improving, requires using adequate practical information within the framework to help begin the process of improving. The use of CI techniques will actually work promptly in the busy environments that businesses find themselves in. The questions asked have confirmed that the framework is suitable and will benefit businesses as

designed. The case studies have proved that this is the case. The data shows that there is a range of barriers; while, following the structured interview after the case study work, none of these barriers existed.

Table 6.12: Potential barriers to business improvement

Question	Yes	No
No business improvement	3	2
Lack of waste minimisation goals	4	1
No business measures	4	1
Fear of change	3	2
Poor top management commitment	3	2
Poor middle management commitment	3	2
Poor supervision commitment	3	2
Poor worker commitment	3	2
Poor technical knowledge of processes	3	2
Production pressure	3	2
Bureaucratic obstacles	3	2
Lack of communication	3	2
Not sure what to do	4	1
Poor problem definition	3	2
Lack of human resources	3	2
Lack of financial resources	3	2
Already stretched resources	3	2
Cutbacks	4	1
No one person responsible	4	1
Lack of waste minimisation knowledge	3	2
Lack of process understanding	3	2
Bureaucracy	3	2
Over complicated improvement programme	4	1
Lack of motivation	4	1
Too many previous failed projects	3	2
Lack of CI knowledge	3	2
No simple CI tool available	3	2
Accepted bad practices	4	1
Business culture	4	1
Negative approach	4	1
Business inflexible	3	2
No incentive system	3	2
No employee development programmes	3	2
Unaware where to seek additional information	3	2
CI techniques not required by customer	3	2
Too busy with day-to-day activities	3	2
Too many problems to deal with	3	2

Figure 6.11 shows a range of answers to the questions asked with regard to the use of process improvement techniques. The people in the case study companies were not experts; however, prior to the case study work, there was some knowledge of CI techniques, but with limited experience of their use. However, by using the designed framework in this research project, their knowledge of CI techniques has now increased.

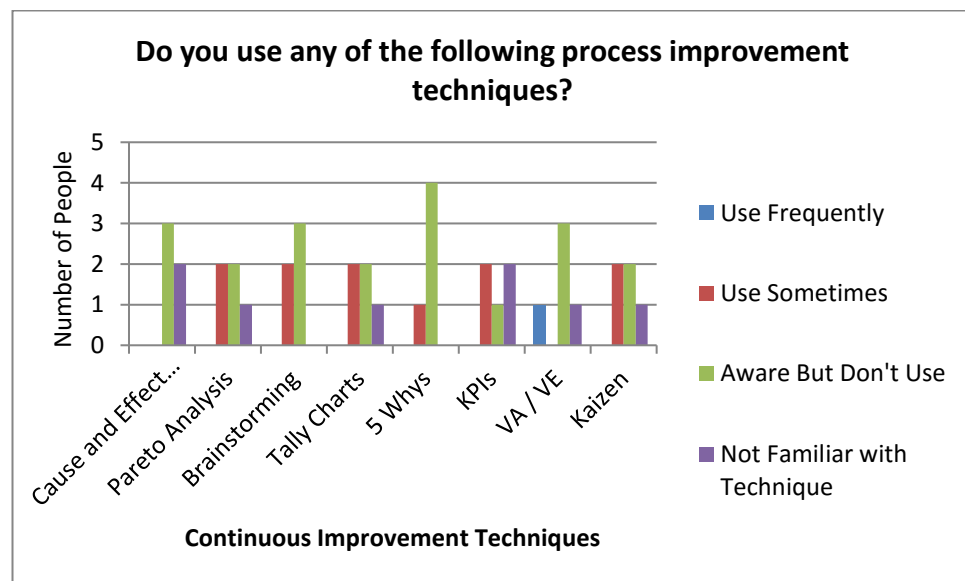


Figure 6.11: Use of process improvement techniques

When asked about any other more complex CI techniques that require extensive training and implementation costs, there was no mention of any other being used. It was later discovered, however, that people were aware of the existence of individual CI techniques such as brainstorming, cause and effect, the five whys and histograms. They were not aware that the collective description was called CI techniques.

Four people were not sure what could be done differently to help businesses use CI techniques. Again, the framework will drive through improvements with the use of CI techniques.

When asked about any reasons for not using any improvement techniques, three people were not sure of any reasons for not using CI techniques. Experience of using the framework has now resolved this issue raised in the structured interviews.

It is pleasing to note that all five people wished to be guided on the relevant sources of business improvement techniques. All five people showed an interest in the framework, which has now been used by everybody.

When asked to list the benefits of using CI techniques, two people were unsure and other people listed improved efficiency, solving problems, reduced waste and improved quality. This awareness has now improved since using the framework to identify improvements from the case study.

It is surprising to note that four people responded that they had not been contacted by a government agency to help support business improvement projects.

When asked if they knew of other businesses that use CI techniques to improve business performance, four replied that they did not. Once the internet portal is implemented, the responses to this question will change with regard to data when COP is activated in the framework for businesses that wish to participate.

All five people stated that they would like to learn more about CI techniques, which has clearly been demonstrated by using the framework in the case study environment.

No-one was aware of any publications, research papers or journals for CI techniques. This was discussed at the time of the case study work and people are now aware where to seek such information.

Only one person was aware of any books on CI techniques. This again was discussed at the time of the case study.

When asked if they were aware which CI techniques were available on the internet, four people were not. Again, using the framework consisting of CI

techniques, histograms, brainstorming, the five whys and cause and effect should help this. Though people in the case study were not aware of all available CI techniques, authors in the literature have identified that there are barriers preventing SMEs from using CI techniques to improve business (Oduoza *et al.*, 2012), this confirms that even if a lack of knowledge is solved, other barriers would still exist.

Three people had been involved with improvement projects and the others were split between the answers or 'no' and 'not sure'. Working with the framework will, again, provide knowledge and practical support.

When asked if customers supported CI improvement initiatives, three stated they did whilst two stated 'no'. Reducing waste within the business will support customer requirements, and this should be communicated to the customers. Promoting improvements, even to the ones that do not necessary promote CI improvement initiatives, can promote a proactive supplier and help to strengthen supplier-to-customer relationships.

When asked if suppliers use CI techniques, four were not sure and one stated 'no'. Once the case study companies have more experience, they may wish to promote the framework approach to the supplier base. This may lead to supplier improvements, which can lead to improved performance to suppliers and result in improvements in the case study businesses.

All five people were interested in reducing business waste and showed significant interest in the framework and using it within the case study companies.

Lack of knowledge was the highest response, occurring among three people. Two answered that they were not sure. By ensuring that the framework is practical to use, there should be an increase in uptake by businesses.

There was a strong response by four people that people do not appreciate the importance of CI techniques. The more projects that are implemented, the more people will appreciate the importance of the framework.

All five people confirmed that they were not confident in using CI techniques. This view has now changed as a result of using the framework.

None of the five people had had any form of contact with universities or colleges. Using the framework, the people at the case study businesses have now had experience of working with the University of Wolverhampton.

'Not sure' scored the highest, with three people answering in this way. Developing more industry-focused solutions to problems, such as the framework in this research, could be of benefit to industry, helping to bridge the gap between industry and universities.

The majority of people agreed that CI techniques could be made easier. The framework makes use of the simplest CI techniques, and this has been proven from the feedback and successes made during the case study work.

When asked why CI techniques are not often used in business, three people stated a lack of awareness, due to over-complicated training programmes. They did not mention what authors had stated in Chapter 2 with regard to financial restraints of SMEs that can cause a lack of management commitment. Nor did they mention problems that are encountered by a failure to learn by doing, knowledge management or other key elements of the developed framework. Two people stated that they were difficult to use. Using the framework has increased people's awareness of CI techniques and this will continue to grow in the future.

The final question was to elicit why some customers insist that their suppliers use CI techniques. Two gave the reason of cost reduction and the others cited supply chain control, improvement of quality and process improvement. Once more, projects are actions, and the development of the internet portal will mean that customers will see the potential benefits of using CI techniques, the gap will be reduced and the barriers removed.

6.14.2 Case Study Work

The structured interview was designed using a systems thinking approach, in terms of looking at all processes and problems at once. The structured interview was also designed to obtain feedback from people within the process to confirm and possibly further develop, and thereby improve if applicable, the framework. People tended to have an average to good understanding of computers, which will serve the framework well when the website is later developed. People also appeared to have a basic understanding of a QMS; some had heard of a few process models and there was very limited knowledge of CI techniques, but there were comments on failed projects. Hines and Rich (1997) are not sure of the benefits or the disadvantages that process models can bring to businesses. It is clear, however, that management teams wish to improve and have welcomed the idea of a quick to learn and use framework to help them. Businesses find themselves under pressure, as reported by many authors. They do not employ any specialist help and have not attended any courses specifically for business improvement. With limited experience of KPIs, this may be something that could be further implemented, certainly in Case Study 2.

In terms of solving problems, people tended to discuss or speak to their manager, but the lack of commitment resulted in no further action. People's understanding of waste was limited to scrap parts and they were not really sure what improvement meant in this area; this was supported by their lack of understanding as to how to reduce business waste in terms of improving business performance and they also struggled to explain the meaning of CI. However, it is interesting to note that, with their knowledge of the Seven Wastes, Hines and Rich's (1997) case is quite reasonable. Prior to visiting the case study companies, there was very limited use of waste minimisation and this was restricted to product downtime (Case Study 1) and quality first-time pass rate. This was evident by the lack of any documented processes or any implementation of a business improvement strategy with any real form of waste minimisation goals or any significant measures.

At the first meeting, it was evident that there was an element of fear of change, this anxiety was soon put at rest, by stating that the framework had previously been trialled with some success and also that it had no financial cost to the business. The senior management needed to demonstrate their commitment and remove bureaucratic obstacles by promoting a proactive business culture that would eliminate any negative approaches. Clear communication must exist within the business and down the organisational structure through to middle management and supervision of the workers in the processes. Management will need to invest resources that may be already stretched (and cutbacks may also be happening) to where the root cause has defined that there is a need. Otherwise, no change will occur. The business will need to be flexible with projects, especially when implementing measures to alleviate the root problems. If an incentive system was introduced, it would probably speed up the process of waste minimisation; this should be implemented by the management once they see some early results. The management will need to support the improvements, especially where it is not customer-driven. They will also be required to allow the time; where everyone is always busy with their own responsibilities. Keeping the time commitment small means that not too many problems will arise. Management will certainly learn from successful projects and they may then implement improvement projects where they have identified issues.

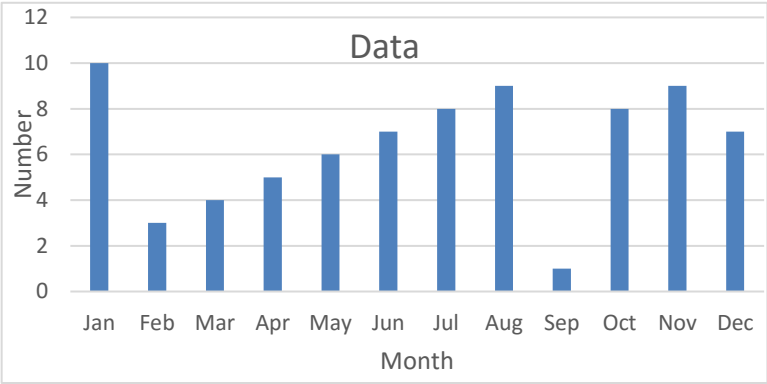
Not all the people in the case study businesses were aware of the technical capabilities of the processes used to manufacture the product and they were not always sure how to minimise problems which, coupled with production pressure, could escalate problems through fear of late deliveries to customers. To improve people's skills within the business, there is a need to ensure that their problems are correctly defined, and they will need to increase their skills in CI techniques. There will certainly be a need for team work to drive improvements where they can learn from each other, especially where the process of improvement is not complicated. The people in the team will need to be motivated and forget past failed projects, starting afresh for each new project to eliminate any current bad practices that affect business performance. As

people learn from the framework and KM, they will develop their skills in learning more about CI techniques and, most importantly where to learn more about them, whether that is from courses, books or the internet. People will learn of the benefits, as they have some experience of success in projects and this will give them confidence to use CI techniques in future projects. During the case study, it was discovered that an improvement in the existing use of CI techniques had been implemented to improve efficiency and discover the root cause of the inefficiencies.

6.15 Continuous Improvement Linked Approach

A breakthrough of an additional contribution to knowledge has occurred whilst using the CI techniques of histograms, brainstorming and the 5 Whys. Under normal circumstances, each of the standard CI techniques has its own separate documentation that is used, this can be seen in Figure 6.12. During the case study work, it was discovered that if the CI techniques were linked, this would help to support a continuous thought flow. This would reduce the process from problem defining through to determination of the root cause. Prior to formalising this approach, an international literature review was conducted to determine if this approach had been used in prior publications. No other author has been found to use this approach. A continuous improvement linked approach has the following benefits: the process from problem to root cause can easily be seen; simplification of the root causes and time reduction are achieved; management is supported; management commitment and support are backed; and the COP can easily see the process that others have adapted, resulting in a more rapid implementation of improvements.

Parts not to
Drawing
Histogram



KPI													
Mth	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Data	10	3	4	5	6	7	8	9	1	8	9	7	

Brainstorming	Five Whys	Five Whys	Five Whys	Five Whys	Five Whys	Preventive Actions
Part not to drawing	Old issue drawing retained by operator on the shop floor	Lack of Drawing issue control on the shop floor	Drawing issue control procedure not communicated to the shop floor supervision and operators			Quality Manager to train the shop floor supervisor and operators in the drawing issue control procedure. Remove all obsolete drawings from the shop floor. Current up to date drawings issued each time for production batches.

Figure 6.12: Linked approach

6.16 Case Study Improvements

It is most important for businesses that wish to improve that the management commitment is demonstrated; the importance and significance of improvement will then be seen by all. The benefits of using the framework, with easy-to-use CI techniques, will minimise waste, and future successes will generate confidence in using CI techniques.

Figure 6.13 shows the final framework as a result of the case study work, where the root causes were achieved without the use of a cause and effect CI technique.

Stage 1 starting the process review, a waste prompt is considered which considers any specific resources that need to be considered for improvement, for example: gas, electricity, scrap, etc. A KPI sample proposal is then considered, which can be used to quantify the problems, for example: drawing errors, process downtime, internal problems.

Stage 2 is the mechanism that drives the process improvement from stage 1 and stage 2 by using: waste identification audit sheet, process KPIs, project sheet and communities of practice.

Stage 3 considers the support required for know-how knowledge; this ranges from: specific continuous improvement techniques, management systems, barriers and case study examples.

Stage 4 decides whether to continue to keep improving or conclude the improvements can be made.

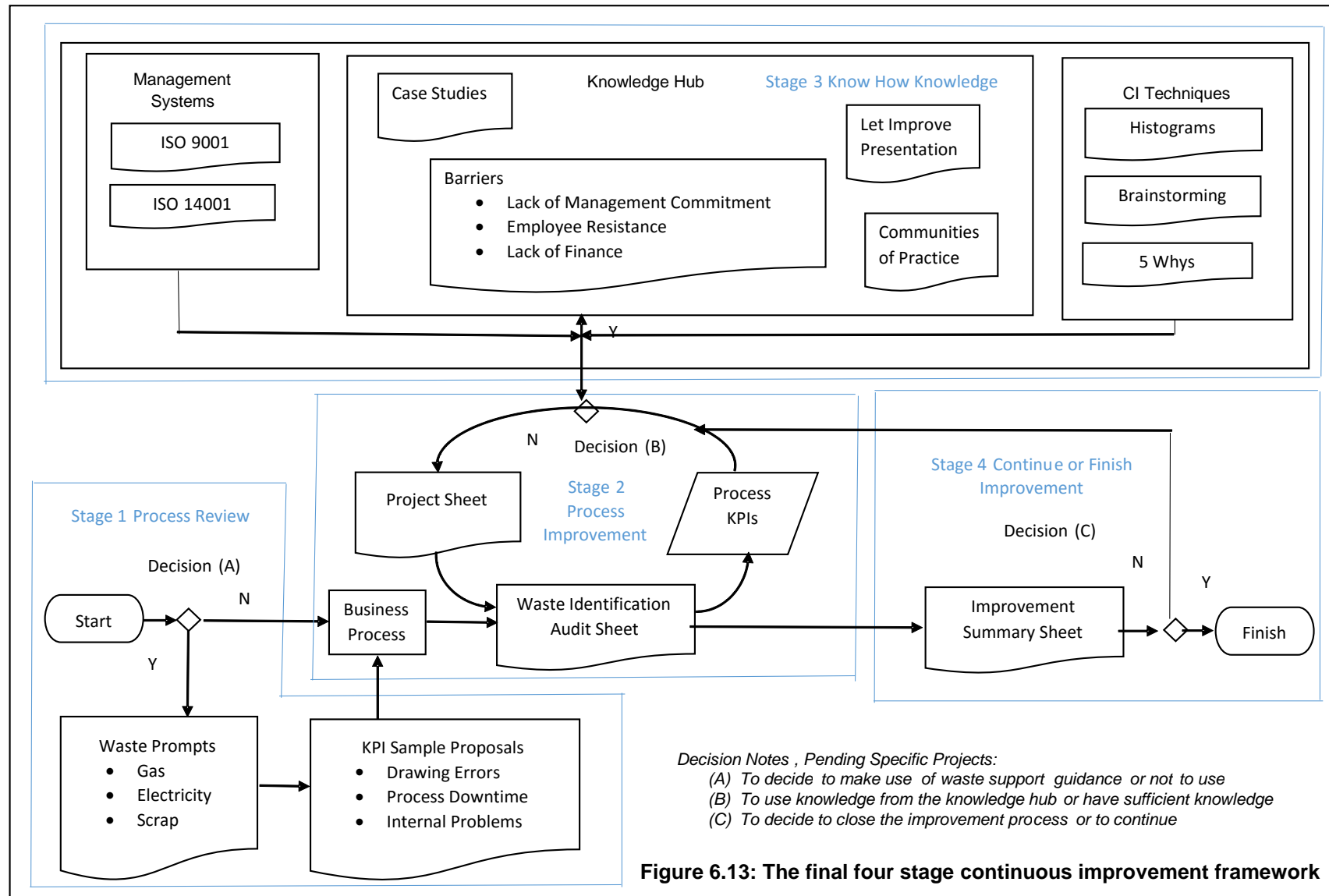


Figure 6.13: The final four stage continuous improvement framework

6.17 Summary

Detail of the case study companies has been explained and case study personnel have now had experience of working with the framework and have identified actions for management implementation from the use of the framework to identify root causes from problems within the business. The framework has been simulated in a sample company where it was proved to make business savings. A comparison of other models has been explored and the framework in this research project has been proven to have advantages, this has also been proved by validating the framework. Both Case Study 1 and Case Study 2 will benefit from management implementation of the actions defined. Feedback in the form of the structured interview has been positive with no real negative issues, this confirms that the framework has actually worked in an industry setting and is also suitable for other businesses to use.

The next section of this research project details the conclusions and recommendations from the research that has been conducted.

Chapter 7: Discussion and Conclusions

7.1 Introduction

The aim of this research project was to develop a framework to support continuous improvement in manufacturing SMEs. This chapter discusses the research process and also presents the conclusions on achieving each of the objectives of this research project. The contribution to knowledge and research limitations are discussed and future research opportunities are identified.

7.2 Discussion of Research Conducted

Businesses are under pressure facing today's demands for profitable solutions that enable them to gain a competitive advantage. The literature review has identified that CI techniques are used by some companies but usually with the support of business professionals. Barriers identified in Chapter 2 are often encountered, which in summary include a lack of management commitment, time and finance restrictions. The information obtained from the literature review was used to develop a conceptual framework. The continuous improvement SME awareness pilot study was also used to develop the framework that will not only support promoted CI techniques in the literature view but, importantly will satisfy the needs of SMEs to improve their performance. The case study work successfully validated the framework to ensure that it would bridge the gap caused by barriers. Such barriers that have been reported by authors and it was important to ensure that it would actually work in an industry setting by identifying the root causes for management intervention. During the case study, it was discovered that the techniques used could be merged to improve learning and seek the root causes of problems. The structured interview also confirmed that the framework developed in this thesis is suitable to support manufacturing SMEs to improve their business performance. Also, not all of the original CI techniques in the pilot study framework had to be used. The following sub-

sections of this thesis continue to discuss in detail in the form of conclusions and also demonstrating that the aim and all objectives have been achieved.

7.3 Conclusions: Achievement of Research Objectives

The purpose of this section is to demonstrate that the aim and objectives of this thesis stated in Chapter 1 have been achieved.

The **first objective** was to critically review available continuous improvement techniques that are value adding to SMEs in order to identify the most efficient techniques used.

The comprehensive literature review has identified CI techniques which are available to businesses in order to help support business performance. The literature review revealed CI techniques such as histogram, brainstorming, control plans, SPC, cause and effect and the Five Whys, which were efficiently used. Other tools such as Value Stream Mapping, Business Excellence Model, TQM, Integrated Quality System, Kaizen, Balanced Scorecard, Six Sigma, Lean Thinking, and Baldrige Award were considered. However they did require elaborate training, professional ongoing support and it must be noted that they were not always successful because of the barriers encountered in their implementation.

The **second objective** was to critically review and identify barriers that prevent SMEs implementing continuous improvement techniques to improve business performance.

Barriers do exist and authors from the years 1992 to 2014 have published and documented 17 barriers that prevent adoption of CI techniques. The top three barriers are: lack of management commitment, employee resistance and insufficient resources.

The **third objective** was to analyse and document the role of key performance indicators, knowledge management and quality management system (for example: ISO 9001, Balanced Score Card and Six Sigma) that could support the use of continuous improvement techniques in an SME environment.

To justify and to get management commitment to solve a problem, the size of the problem needs to be measured. This can be achieved by using a KPI to quantify the size of the problem. SMEs attempting to solve a problem without prior or limited experience will need relevant knowledge. Training only does not necessarily work; however learning by doing can provide valuable experience enhanced by communities of practice approach.

The **fourth objective** was to develop a conceptual framework which was user-friendly and thereby propose appropriate continuous improvement techniques and methods available to SMEs without unnecessary intervention from business professionals.

It is essential to use CI techniques that will support the framework and not create unwanted barriers for SMEs. Typical CI techniques that are user-friendly are: brainstorming, histogram, Five Whys, cause and effect, control plans and SPC. The CI techniques chosen for this study were based on the concept that they did not require extensive training and financial investment, they are: histograms, brainstorming, Five Whys and cause and effect. Control Plans and SPC were considered, however they did require lengthy training and experience to implement. For the purpose of this research it was decided therefore to use low-cost and quick-to-learn techniques. The conceptual framework developed is presented as Figure 4.6. It shows input from the customer, then waste identification, followed by communities of practice and knowledge management process and then CI techniques. The final output is the customer product/service provided.

The **fifth objective** was to collect and analyse data of SMEs' awareness of the continuous improvement technique and the barriers to it. To validate the developed framework in a case study environment focusing on business

performance and thereby encourage continuous improvement uptake by manufacturing SMEs.

The continuous improvement SME awareness study questionnaire conducted was implemented in 2008, and 800 random SMEs were chosen. There was a response from 50 SMEs (6.25% response rate) and descriptive statistics was employed for analysis of the data.

The barriers faced by SMEs that prevented them from improving were identified as: lack of waste minimisation goals 70% (35 of the 50); lack of resources 72% (36 of the 50); poor management commitment 72% (36 of the 50); poor technical knowledge of processes 58% (29 of the 50); and production pressure, 84% (42 of the 50). It is interesting to note that 84% had production pressure but 70% did not have waste minimisation goals and 58% lacked the technical knowledge of processes.

The results revealed that quality management systems were implemented by 92% (46 of the 50) SMEs where 70% implemented ISO 9001. Interestingly data revealed that 52% (26 of the 50) SMEs employed business professionals.

Awareness of CI techniques used by SMEs revealed that brainstorming was frequently used by 10%; used sometimes by 28%; 58% were aware but did not use while 4% were not aware of it. Other CI techniques showed similar trends, that the SMEs were aware of them but did not use them. This raises the question about the commitment to use the tool for waste minimisation when the pressure to deliver is high.

When asked about the reasons why SMEs did not implement CI techniques, 40% of the respondents noted that it was complicated, 26% stated it was due to time restraint, unwillingness was mentioned by 8%, cost by 6% and lack of awareness by 2% of the respondents. This indicates that some of the CI techniques are only used sparingly and occasionally.

The conceptual framework developed was modified based on the empirical results. The framework was not complicated to use, was quick to learn, cost-

effective, successfully applied and therefore there were no potential barriers that could affect its implementation. A framework developed which provides guidance in the use of CI techniques will support activities such as: prompts and other user successes to learn from, etc. This would also reduce the barriers to the uptake that have been identified. Merely simplifying CI techniques would not have translated into successes, as there would not be any learning from Knowledge Management process and the application of a communities of practice approach in achieving a learning organisation environment. This resulted in a four stage continuous improvement framework. The stages are: 1) review the current process to be improved; 2) identify possible improvement in terms of waste prompts; 3) knowledge know-how to support transfer of proven continuous improvement techniques; and 4) continual review of the process to quantify the improvements.

The framework was validated using two SMEs who used the framework to achieve business improvement. These were proactive. Feedback from the case studies included: 'quick and easy to learn, practical, no external assistance required, cost-effective, and root causes can be easily identified for management action'. During the case studies it was also discovered that combining the techniques used could even speed up the process of finding root causes to problems. Overall, the new framework generated substantial savings for the case companies, of £27,500 for SME 1 and £1,366,055 for SME 2.

7.4 Contribution to Knowledge

The research developed here was aimed at developing a framework that could help SMEs to improve productivity and minimise waste. The framework encompasses four stages: 1) review of the current process to be improved, 2) identification of possible improvement in terms of prompts, 3) knowledge know-how to support transfer of proven continuous improvement techniques, and 4) continual review of the process to quantify the improvements.

1. The framework is unique, novel and therefore will support SMEs in the manufacturing sector to add value to the business process; this was achieved by the adaptation of CI techniques and quality management systems, along with knowledge management and communities of practice aspects which enhance productivity while minimising waste.
2. The Knowledge Hub retains information on past projects for SMEs to learn from in order to find root causes and improve business performance and to make cost savings.
3. CoPs made up of SMEs operating in a similar business environment are able to share examples of good practice.
4. An improvement in the application of the use of well-established CI techniques that can be merged into one technique has been achieved during this research project. This reduces the amount of documentation required and time taken from identification of a problem to the identification of the root cause. To determine a root cause of a problem under normal circumstances when using available CI techniques such as: histograms, brainstorming and the Five Whys, each technique is documented independently. During the case study it was discovered that if the CI techniques were linked together in one document this would help to support a continuous thought flow from problem definition to root cause. This approach was also found to reduce the time required for determining the root causes of problems.
5. The framework in this research has also overcome the uncertainty of high investment improvement projects which have failed in the past due to barriers, for example lack of management commitment and lack of resources. This study demonstrates that not all improvement projects published are successful, even with incurring expensive costs, extensive hours or days of training and with the use of costly business professionals.

The acknowledged benefits of the framework are:

- The framework will not only benefit existing businesses but also new business ventures prior to process implementation. Knowledge to new product and process introduction by use of the framework to prevent problems before they occur could also be achieved. This would enable the SMEs to manage their costs and enhance resource efficiency.
- The case study companies found the framework beneficial and are using it to manage their business to maximise their output. This has helped them to manage lead and takt time to customers..
- The framework is user-friendly and consequently SMEs will not need to depend on external professionals to train them to use it.
- During the development of the framework it was discovered that the root cause could still be determined without using the cause and effect technique. This was achieved by using the CI techniques, brainstorming, Five Whys and also supported by histograms to represent process data in the form of a KPI. This approach proved that the root cause of a problem can be found more quickly and also with reduced documentation than previous research studies had identified in the literature.
- Unlike other improvement models, such as 6 Sigma, Kaizen or TQM, the framework is quick to learn (less than 30 minutes in a case study environment and without prior CI technique experience) and has been proven in a case study environment to provide rapid successful results return.
- Unlike other complex, expensive available software, the framework in this research has not been costly to a manufacturing SME, either in terms of purchase costs, on-going licence fees or external training and support fees. The framework developed in this research project has specifically prevented the financial barriers to manufacturing SMEs, achieved cost-effectively.

7.5 Research Limitations

This research is limited to helping manufacturing SMEs that do not implement continuous improvement techniques and do not employ business professionals. It is also limited to reducing the gap caused by barriers of low uptake for CI techniques and to identifying root causes to problems for management implementation in SMEs.

The sample size is low, the framework is a generic framework that has been trialled on two case study companies: one was a high-precision low-value component business and the other was a low-volume high-value component business. SME manufacturing companies can use the framework to drive business improvements. The framework uses well-established CI techniques such as histogram, brainstorming and Five Whys to deliver a root cause analysis. Over time, projects that are successful through a communities of practice approach and an increased knowledge hub will increase and more knowledge will be available.

People of different learning capacities may vary depending upon their own particular speed of absorbing information.

The framework has not yet been trialled on other larger businesses or other business outside of the Midlands UK. However there are plans to increase the framework exposure to such businesses.

The management of the business need to create a small dedicated team to use the framework to identify problems and seek root causes. All root causes are provided to the management of the business for their implementation. They need to be responsible for the effective implementation of any suggested improvements. Projects may vary in length according to the time given by management and the time worked by the teams.

Any cost savings may vary due to the typical overhead value that is used to calculate a typical charge of the business, this may also vary from process to process.

7.6 Conclusion

Chapter 1 sets the scene and also identifies the issues that SMEs face with business performance issues on a day-to-day basis. Many companies struggle with competitiveness in the market place; the global market has also increased and the number of mergers has produced many large companies operating on an international basis. These companies are always striving to produce the best possible product at the lowest price in order to remain competitive. If a framework that actually works was available to help businesses improve performance, it would reduce the pressure that they find themselves in on a day-to-day basis. To become more competitive, a company must involve all of its employees at all levels of the business, and there are many different concepts and philosophies available to companies to help them achieve this (Ljungstrom, 2005).

Chapter 1 sets the aim and objectives for this research to solve the problems that SMEs face in terms of the barriers that prevent business improvement.

Chapter 2 presents a comprehensive international literature review, identifying CI techniques that have been proven to contribute to process improvement. The following issues were found: Looking at VSM, which is an ill-defined toolkit (Hines and Rich, 1997), Brunt (2000) also found that this technique is still an ongoing subject of investigation. Arvelo (1995) questions if CI includes Kaizen and other process models that require professional support, such as TQM. In this research, this philosophy has been stripped back to its basics for simplicity's sake, to ensure that the framework will actually work in industry. A common barrier is lack of management commitment (McQuater *et al.*, 2000) and, therefore, management support is critical. This author also found that

simple problems require simple tools. Dwyer and Copland (2007) also state that CI tools do not require much training. Management systems have been proven to support businesses but they require professional support (Munro-Faure *et al.*, 1993). Mulhaney *et al.* (2004) also supports the view that ISO 9001 can help drive CI through businesses, although it is important to keep the system simple and use objectives to improve customer service. The ISO 9001 framework provides many benefits that can be used to improve a business (Hall, 1994).

There are thousands of related references to the key words 'continuous improvement', which are easily obtained from a variety of media and locations. There are a variety of CI tools that require differing levels of skills and understanding. The work of Smith *et al.* (2010) in the Midlands has determined that there is a gap in uptake of these CI techniques by SMEs. The fact that there is a gap justified the need for research in this field to help businesses make use of the many CI techniques to help support them in minimising business waste.

Knowledge management would be of benefit to people who did not have any prior experience of using the framework. By using a systematic approach, the framework promoted CI to activate a programme of waste minimisation. This was achieved by learning and doing. KM will also be of great benefit for businesses that have yet to tackle problems within their business and to learn from others who have used this framework.

A systems thinking, systems practice approach was researched; however, it would require detailed training to understand the methodology more clearly. This was a common view from both case study businesses. The feedback was based on the systems thinking, systems practice methodology as an attempt to analyse the broad sweep of issues within a business. Such concerns are commonly raised by authors who have published papers on this subject.

The comprehensive literature review in this research project includes widely published papers in support of businesses wishing to prevent the problems that can occur when processes are not effectively controlled. Other factors such as

senior management commitment, training and management systems are critical to the success of waste minimisation, which, in turn, can help to improve business efficiency and, therefore, business performance. This demonstrates that something new and different and, most importantly reliable is required.

Chapter 3 defined the research methodology to determine what is actually happening in industry. The following research methodologies were used to evaluate the published work in this area and conditions in industry: a literature review, a postal questionnaire, case study work and structured interviews. The information obtained from the research methodology supported the initial development and implementation of a framework to minimise waste, which would reduce the gap in the uptake of CI techniques by SMEs.

Case studies identified would help to provide a further understanding of what is happening in industry. Its purpose would be to support data gathering, data feedback, data analysis, action planning, implementation and evaluation. This can then be fed back into the framework for further development purposes. KM supports the action learning of people in the case study companies to learn about their business waste and the use of the framework. This is achieved by learning from experience and from results, whether they be positive or negative.

The methodology was carefully researched and planned in this research project. The research papers obtained have fully supported the knowledge obtained from the literature review in order to obtain information to support the use of the framework for use in an industry environment. Prior to any case study work, the planned methodology process was successfully trialled in a pilot study business to prove all methods and processes would actually work. The case study work was later well supported by all the people in the case study businesses. During the methodology work, continual consideration was in mind for: no barriers, such as a lack of management commitment, or other obstacles, as identified in the literature review. The framework needs to be a low-cost one to use, costing only people time so that a financial and training barrier was not encountered. This was achieved by careful consideration of researched

publications and data collection. Using the framework provided, the people in the businesses involved in the case study work had the chance to gain experience of applying CI techniques to discover root causes for management intervention. Feedback later in this research during the case study work in the form of the structured interview has confirmed that the framework is suitable, without any further modifications being required.

The framework was developed as outlined in Chapter 4, and all previous chapters were taken into consideration, with a particular focus put on the aims of this research that the framework had to deliver business improvements to a business in a practical and easy way. The lessons of the past were reviewed from past authors who have published on a variety of CI techniques, to ensure that the pitfalls they encountered were avoided. The framework evolved from a vision to a concept and then to a successful working framework. During the development of the framework in Chapter 4, suitable CI techniques were identified for use within the framework: brainstorming, histograms, Five Whys and cause and effect. They are considered to be the most common and appropriate continuous improvement tools available to SMEs that can support them. The justification for the use of these CI techniques over other available CI techniques was the low-cost and potentially rapid results that can be gained from identifying the problem, as well as identification of the root cause. This approach would also engage management support and prevent a lack of management commitment.

The framework was developed with an open mind, and then it was focused in order to achieve the objectives of this research. On reflection, the key to the success of the simplicity was the use of basic CI techniques, the Plan-Do-Check-Act approach of problem solving and the KM of learning by doing. If successes are achieved, there is a greater chance that management will commit to further projects for the future, overcoming barriers and increasing the uptake of CI techniques.

The framework developed from this research has proved that it will reduce the reported barriers in an industry environment, as identified in academic papers. The framework has been developed to encourage continuous improvement uptake by manufacturing SMEs.

Chapter 5 reviewed the data obtained from a pilot study from 50 SMEs in the Midlands, UK. The pilot study was conducted prior to the case study work to prove the initial concept design of the framework. The pilot study obtained positive interest from SMEs that were willing to share their information on wanting to improve their business but encountering problems and barriers. The pilot study did confirm that the initial concept design of the framework could be suitable to support manufacturing SMEs to prevent barriers identified in the literature review and improve their business performance.

The case study companies in Chapter 6 were a low-volume, high-cost product and a high-volume, low-cost product respectively. Regular site visits also took place to understand and appreciate how the businesses operated and to observe the process of using the framework. It was clear from meetings that the management had knowledge of CI techniques, systems and improvement projects; however, there was no implementation of the use of CI techniques in either business. Also, one common barrier identified that caused problems was that there was very little senior management commitment to preventing problems.

Using the framework, the case study companies validated the framework. This was achieved by actually using the framework to support the process of the identification of the real problems affecting the business and to seek the root causes of the problems. The management in the case study process did provide their commitment and support to the case study work, and they soon began to see small improvements at the outset of using the framework. The validated framework has successfully identified improvements for management implementation. The case study companies also managed to arrive at the root causes of identified problems using the framework, but without having to use

the cause and effect method. Instead, they only used histogram, brainstorming and the Five Whys CI techniques. Cause and effect has now been removed from the final version of the framework.

A structured interview obtained information from the case study work to ensure that the framework was suitable for industry to implement business improvements. Questions were also designed to explore issues and barriers identified in Chapter 2. Questions ranged from the level of Microsoft experience of the participants, to determine if they could use the framework if it were designed in Word and Excel formats, to any previous knowledge of techniques, to support and commitment from management, to specific questions about their business environment.

The case study companies provided the following positive feedback: the framework was quick to learn, there were no difficult methods to learn, it was practical, no outside assistance was required, it was low cost and root causes were easily identified for management action.

An analysis of the feedback in Chapter 6 has proved that all the problems that were affecting business performance identified in the case study work have had root causes identified and that the framework is suitable and is ready for large-scale use by industry.

Chapter 7 discusses the work completed over the course of the project and draws conclusions from all the work in support of the framework from the other chapters. The chapter bridges the gap between the issues identified in the literature review to solving the problems identified by the development and validation of a framework that actually works and solves problems. It confirms that all objectives have successfully been achieved. A contribution to knowledge has been identified that will be of benefit to both authors of publications and industry. A research limitation is also identified for this research project. This chapter concludes this research and identifies further research work to be done to ensure businesses gain the most benefit from the process framework when launched on the internet. The next and final section also suggests further

research that could possibly advance SMEs even further to gain additional benefits from a framework that can help to support business improvement projects.

7.7 Future Research

It has been proven in this study that the framework developed actually works in a manufacturing SME environment and therefore it has satisfied the project aims and objectives. Recommendations for future research are:

- The framework could be researched in other manufacturing SMEs, and also other business sectors including organisations not only in the UK but world-wide.
- Communities of Practice (CoPs) can access information through a proposed web based portal which would enable CoPs to share knowledge about the four stage framework developed to improve business productivity while minimising cost. The advantage of developing a portal is that information can be stored and shared by businesses within the practice. The portal will also promote knowledge management with continuous updates of current information.
- A mobile application for a smartphone or tablet could possibly be researched and developed. This could be used to track the usage and the impact of the application of the four stage framework.

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Appendices

Appendix 1: PowerPoint Presentations

Appendix 1a: Let's Improve

Slide 1

Let's Improve

Simple
This presentation has been created to help increase the uptake of simple-to-use continuous improvement techniques that can help improve your business.

Please take your time to follow the simple stage by stage process.

Slide 2

Let's Improve

Use the framework from the following:

- Random business audits
- Key Performance Indicators
- Meetings
- General feedback

Slide 3

Let's Improve

Business improvement benefits:

- Improved business performance
- Saving resource & money.

Take your time, do not rush, and you may be pleasantly surprised by the results.

Slide 4

Let's Improve

The framework has been developed to be easy to use, with a collection of simple continuous improvement techniques that can easily be applied to your business.

Slide 5

Let's Improve

Use the sample ideas listed here in the Wastis Prompt; they can be used to develop possible ideas for improvements in your business.

Slide 6

Let's Improve

Consider the sample Key Performance Indicators (KPIs) that could quantify business waste activities in your company.

Slide 7

Let's Improve

Walk around your business & look at the various areas, write down areas of the business that could benefit from a Key Process Indicator (KPI). Would implementing a project unlock business waste for you?

Slide 8

Let's Improve

Making use of the above format to monitor any KPIs that you introduce, it can also show the potential savings that could be achieved.

Slide 9

Let's Improve

If you have a process problem that requires many actions to be completed, use this format to monitor the actions required.

Slide 10

Let's Improve

Using the Improvements Summary will show the overall savings to your business.

Slide 11

Let's Improve

The framework consists of 3 continuous improvement techniques, which are explained within the Process Tool:

- Histogram
- Brainstorming
- 5 Whys

Slide 12

Let's Improve

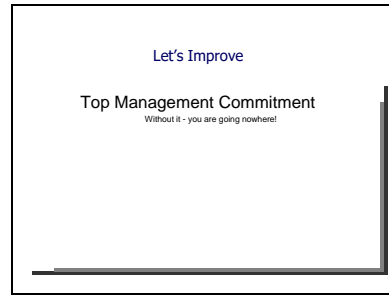
Some important facts to consider!

Slide 13

Let's Improve

Top Management Commitment

Without it - you are going nowhere!

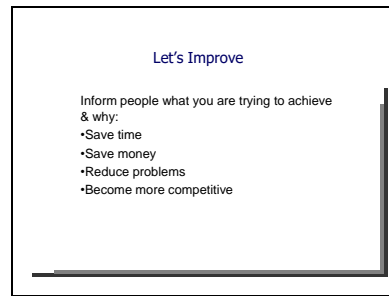
A presentation slide with a white background and a black border. It features the title 'Let's Improve' in blue, followed by 'Top Management Commitment' in black, and a subtitle 'Without it - you are going nowhere!' in small black text. A decorative L-shaped line is in the bottom right corner.

Slide 14

Let's Improve

Inform people what you are trying to achieve & why:

- Save time
- Save money
- Reduce problems
- Become more competitive

A presentation slide with a white background and a black border. It features the title 'Let's Improve' in blue, followed by the text 'Inform people what you are trying to achieve & why:' in black. Below this is a bulleted list with four items: '•Save time', '•Save money', '•Reduce problems', and '•Become more competitive'. A decorative L-shaped line is in the bottom right corner.

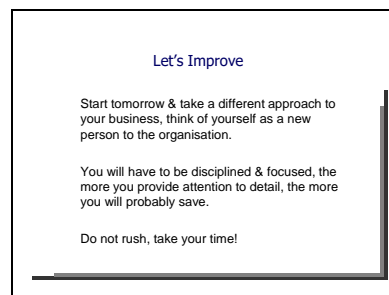
Slide 15

Let's Improve

Start tomorrow & take a different approach to your business, think of yourself as a new person to the organisation.

You will have to be disciplined & focused, the more you provide attention to detail, the more you will probably save.

Do not rush, take your time!

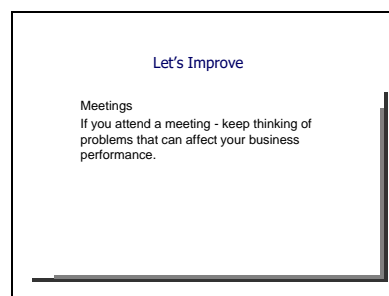
A presentation slide with a white background and a black border. It features the title 'Let's Improve' in blue, followed by three paragraphs of black text. The first paragraph encourages starting tomorrow with a new approach. The second paragraph states that discipline and focus are needed to save through attention to detail. The third paragraph advises not to rush. A decorative L-shaped line is in the bottom right corner.

Slide 16

Let's Improve

Meetings

If you attend a meeting - keep thinking of problems that can affect your business performance.

A presentation slide with a white background and a black border. It features the title 'Let's Improve' in blue, followed by the section header 'Meetings' in black, and a paragraph of black text advising to keep thinking of problems during meetings. A decorative L-shaped line is in the bottom right corner.

Slide 17

Let's Improve

Audits
Walk around the offices & the shopfloor & look for areas that can cost time & money.

Slide 18

Let's Improve

Write down the issues that you would like resolved.

Slide 19

Let's Improve

Some sample concepts to help you, where you could benefit from using the framework.

Slide 20

Let's Improve

Sample Project Concept 1

Key Performance Indicators (KPIs)
Start measuring 2 or 3 KPIs in the business (do not have too many to start with). When you take actions you should be able to see the improvement of the KPIs.

Some examples of KPIs:

- Sales: Quotations to orders / Specification errors.
- Design: Bill of material problems / drawing issues.
- Purchasing: Supplier late deliveries / Supplier quality issues
- Production: Late delivery / Downtime.
- Quality: External / internal rejects

-Resources:

- Gas
- Electricity
- Water
- Packaging
- Raw materials
- Paper

Slide 21

Let's Improve

Sample Project Concept 2

Overproduction

Go & take a look around the business.

Record the quantity of part numbers & descriptions of components that have been made & that are to be scrapped.

Find the cost of these parts and calculate the total cost of overproducing.

Slide 22

Let's Improve

Sample Project Concept 3

Waiting

Go to the shopfloor, ask operators typical reasons why they have to wait & are unable to conduct their duties.

Consider a simple log & ask the operators to record any waiting time.

Using a typical labour rate you can calculate an overall cost.

Do not restrict yourself to manufacturing, look at Sales, Engineering, Purchasing etc.

Slide 23

Let's Improve

Sample Project Concept 4

Transport

Visit the shopfloor, speak to people who move product around the business. Is there any unnecessary transport?

Measure the additional time required.

Seek an hourly rate & calculate the cost.

Slide 24

Let's Improve

Sample Project Concept 5

Work-in-Process

Walk out on the shopfloor, locate some product that is collecting dust

Record the part number & part description & find the total cost of the parts.

Slide 25

Let's Improve

Sample Project Concept 6

Movement

Visit the shopfloor, talk to the operators & observe where they have to get their tools, materials & communication from.

Start to measure the excess time taken.

Determine an hourly labour rate & determine the cost.

Slide 26

Let's Improve

Sample Project Concept 7

Un-necessary Processing

Visit the shopfloor & speak to the operators: ask them what jobs need to be reworked & why?

Determine a cost using additional labour time and material costs.

Slide 27

Let's Improve

Sample Project Concept 8

Defective Product

Ensure that you record quality defects when they occur.

Record part number, description & quantify.

Calculate the cost of the part, plus the cost to rework or remake.

Slide 28

Let's Improve

Plan - Do - Check - Action

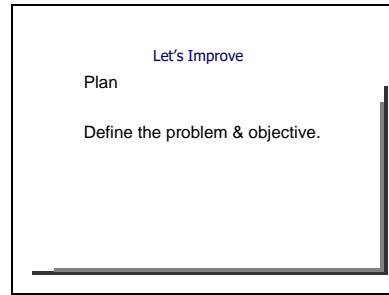
"A simple well-proven process"

Slide 29

Let's Improve

Plan

Define the problem & objective.

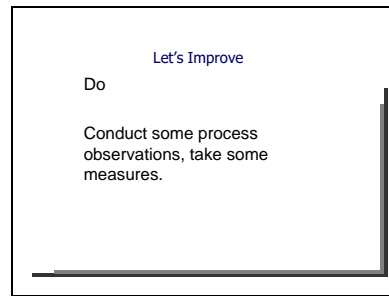
A rectangular slide with a black border. The text is centered. At the bottom, there is a thick horizontal line and a vertical line on the right side, forming an L-shape.

Slide 30

Let's Improve

Do

Conduct some process observations, take some measures.

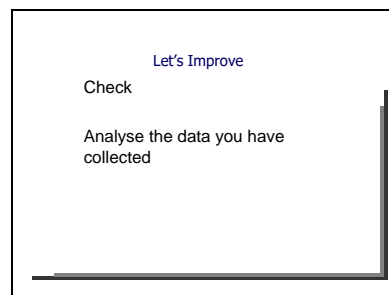
A rectangular slide with a black border. The text is centered. At the bottom, there is a thick horizontal line and a vertical line on the right side, forming an L-shape.

Slide 31

Let's Improve

Check

Analyse the data you have collected

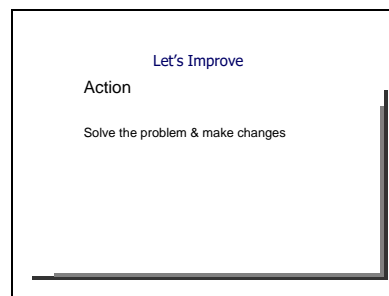
A rectangular slide with a black border. The text is centered. At the bottom, there is a thick horizontal line and a vertical line on the right side, forming an L-shape.

Slide 32

Let's Improve

Action

Solve the problem & make changes

A rectangular slide with a black border. The text is centered. At the bottom, there is a thick horizontal line and a vertical line on the right side, forming an L-shape.

Slide 33


A rectangular slide with a black border. It contains three lines of text: "Let's Improve" in blue, "All the very best." in black, and "Thank You For Your Time" in black. A decorative graphic of three vertical bars of increasing height is on the right side, and a horizontal line is at the bottom left.

Let's Improve

All the very best.

Thank You For
Your Time

Slide 34

A rectangular slide with a black border. It contains four lines of text: "Let's Improve" in blue, "Thank You For Your Time" in black, and "If you have any questions please email me: pgs@sky.com" in black. A decorative graphic of three vertical bars of increasing height is on the right side, and a horizontal line is at the bottom left.

Let's Improve

Thank You
For
Your Time

If you have any questions please email me:
pgs@sky.com

Appendix 1b: Histograms

Slide 1

Histograms

Hello
&
Welcome

Slide 2

Histograms

What is a Histogram?
A histogram is a bar graph
representing the frequency of
occurrences or classes of
data.

Slide 3

Histograms

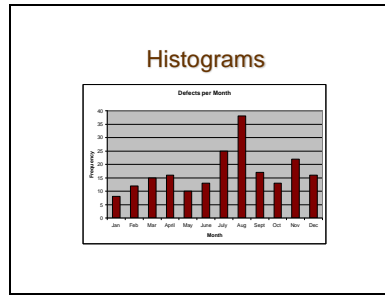
A histogram can help to
organise data to enable it to
be seen in a simplistic way.

Slide 4

Histograms

The purpose of a histogram is
to gain knowledge from data.

Slide 5

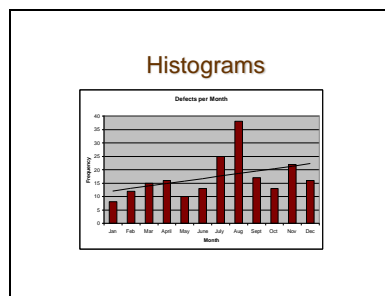


Slide 6

Histograms

Add a trend line & it can inform you whether you are improving or getting worse!

Slide 7



Slide 8

Histograms

Collating the data:
A simple tally chart is used

Slide 9

Histograms

Classes	Tally	Total
Jan		8
Feb		12
March		15
April		16
May		10
June		13
July		25
Aug		35
Sept		17
Oct		13
Nov		22
Dec		16

Slide 10

Histograms

Decisions can easily be made
when information is shown in
a histogram.

Slide 11

Histograms

Thank you
for
your time

Appendix 1c: Brainstorming

Slide 1

Brainstorming

Hello
and
Welcome

Slide 2

Brainstorming

Brainstorming is a tool to help develop ideas to identify actions to seek the root cause of a problem by using a technique called 5 Whys.

Slide 3

Brainstorming

Important:

- Not to criticise
- Be creative
- Build on ideas

Slide 4

Brainstorming

Conducting brainstorming:

- Decide on an co-coordinator
- Set a time limit, (5-15 minutes)
- State the topic of the brainstorming session

Slide 5

Brainstorming

Collect everyone's ideas:

- Structured – rotating around the group.
- Unstructured – call out ideas randomly.

Slide 6

Brainstorming

Record & display the ideas
clarify each idea after it has
been suggested to ensure the
team fully understand the
idea.

Slide 7

Brainstorming

An example:

In a factory a hole is drilled out
of position in a component.
This causes frequent
customer concerns to occur.

Slide 8

Brainstorming

Using a multi-disciplined team
the potential reasons were.....

Slide 9

Brainstorming

- We have always done it this way.
- There is never enough time to do the job properly.
- What do you expect with the type of labour we have.
- The equipment is very poor.
- Need a drilling jig.
- It does not matter we rework them all the time.
- There are more important things to consider.

Slide 10

Brainstorming

After some discussion the one in bold was investigated.

- We have always done it this way.
- There is never enough time to do the job properly.
- What do you expect with the type of labour we have.
- The equipment is very poor.
- Need a drilling jig**
- It does not matter we rework them all the time.
- There are more important things to consider.

Slide 11

Brainstorming

"Need a drilling jig"

It was made and installed in the production line & guess what?

It worked – solving the problem, And was even quicker than trying to align the part in position by hand.

Slide 12

Brainstorming

The idea saved time & also prevented rejects customers.. Total saving per year was £10,000 – not bad for 1 hours work!

WHAT CAN YOU SAVE?

Slide 13

Brainstorming

Thank you
for
your time

Appendix 1d: Five Whys

Slide 1

5 Whys

Hello
and
Welcome

Slide 2

5 Whys

A simple technique that can deliver root causes in a minimum of time.

It can support the brainstorming technique to drill down further to seek a root cause of a problem.

Slide 3

5 Whys

For every effect there is a cause.

Slide 4

5 Whys

When searching for the root cause it is best to reflect on what has caused the effect.

Slide 5

5 Whys

Key elements:

- Define the problem.
- Honesty in answering the questions.
- Determination to get to the root cause of problems.

Slide 6

5 Whys

Can be used in most situations where there is a problem & a solution is required.

Slide 7

5 Whys

Asking the question “Why?” repeatedly, can often help to seek the root cause.

Slide 8

5 Whys

By involving a team of people 5 Whys will become – an even more powerful tool.

Slide 9

5 Whys

Example:

Problem – Manufactured components are short delivered on quantity to a customer.

Slide 10

5 Whys

1. Why are parts missing – because we are always rushing.
2. Why – Because the packing specification is wrong.
3. Why – Because the parts listing is wrong.
4. Why – Because the sales department have got it wrong.
5. Why – The customer has amended the quantity that they require.

Solution, when changes occur ensure that they are controlled & effectively communicated & that Parts Lists & Check Lists are accurate.

Slide 11

5 Whys

Thank you
for
your time

Appendix 1e: Cause & Effect

Slide 1

Cause & Effect

Hello
and
Welcome

Slide 2

Cause & Effect

A cause & effect diagram is also known as an Ishikawa or "fishbone" diagram.

A technique that can support 5 Whys to group complex problems.

Slide 3

Cause & Effect

Categories that problems often fall into are:

- People
- Methods
- Materials
- Facilities
- Environment

Slide 4

Cause & Effect

Encourages group participation & uses group knowledge.

Slide 5

Cause & Effect

Easy – to – follow process that does not require any investment.

Slide 6

Cause & Effect

Cause & effect:

- Understand many causes to an effect.
- Displays the relationship of causes that contribute to an effect.
- Support improvement.

Slide 7

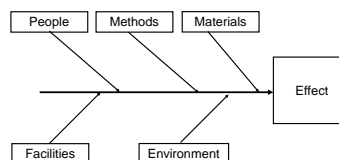
Cause & Effect

Can provide a fast & effective solution where problems contain multiple causes.

Slide 8

Cause & Effect

Skeleton format

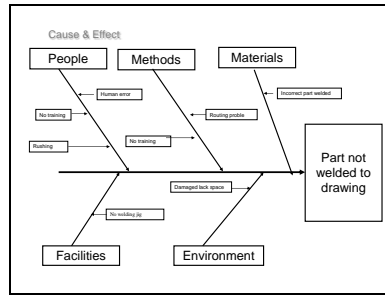


Slide 9

Cause & Effect

A sample problem:
Part welded out of position to drawing tolerance.

Slide 10



Slide 11

Cause & Effect

No welding jig.

A welding jig was made to fool-proof the problem. This ensured that all future parts were located correctly in position.

Slide 12

Cause & Effect

Thank you
for
your time

Appendix 1f: ISO 9001

Slide 1

ISO 9001

Hello & Welcome

Slide 2

ISO 9001

Background

ISO 9001 stems back many years.

- Defence standard 05/21
- BS 5750
- ISO 9001

Slide 3

ISO 9001

Introduction

ISO 9001 is an international management system that is accepted across the world.

Produced by industry for industry.

Well proven – process based system.

Top businesses use ISO 9001 to drive competitiveness.

Slide 4

ISO 9001

Benefits

- International status.
- Opportunity to obtain large contracts.
- Competitive edge.
- Improved customer satisfaction.
- Increased profitability.
- Improved business performance.
- Improved control.
- Increased efficiency.
- Continual improvement.

Slide 5

ISO 9001

Process Approach

- Sales
- Engineering
- Purchasing
- Production
- Despatch
- Delivery
- After-Sales

Supports ongoing control for all processes within a business to provide customer satisfaction & meet customer requirements.

Slide 6

ISO 9001

Documentation

The documentation required forms a collection of procedures & forms (the system) that satisfy:

- Business requirements.
- ISO 9001.

Format normally used:

- Quality Policy Manual
- Operations Procedures
- Works Instructions

Slide 7

ISO 9001

General Requirements

- Processes required to form the system.
- Sequence & interaction of processes.
- Determine criteria & methods to ensure that all processes are effective.
- Availability of resources & information necessary for processes.
- Monitor, measure & analyse processes.
- Implement Continuous Improvement.

Slide 8

ISO 9001

Control of Records

•Specifications	•Calibration Log
•Order amendments	•Concern Form
•Purchase orders	•Internal Audit Report
•Supplier Questionnaire	•Invoice
•Job / Route / Process Cards	•Application for Credit
•Despatch Notes	•Document Change
•Training Records	•Inspection Sheet
•Management Meetings	•Engineering Drawing
•Design input / output	•Parts List
•Process Control Sheet	•Customer Questionnaire

Slide 9

ISO 9001

Management Responsibility

- Management commitment – supporting the system & supporting the people to ensure that it is effective.
- Communication to the organisation.
- Statutory & regulatory requirements.

Slide 10

ISO 9001

Customer Focus

Achieving:

- Customer requirements.
- Delivery dates.
- Quality.
- Service.
- Satisfaction.

Slide 11

ISO 9001

Quality Policy

- Suitable for the business.
- Satisfies ISO 9001.
- Includes a commitment to continually improve.
- Provides a framework for establishing objectives
- Communicated & understood.
- Reviewed for suitability.

Slide 12

ISO 9001

Objectives

- Planning & setting achievable objectives.
- Improving the business for example:
 - Improve efficiency.
 - Improve customer delivery dates.
 - Reduce process downtime.
 - Prevent quality repeating issues.
 - Reduce drawing issues.
 - Improve supplier performance.
 - Minimise stock-outs.

Slide 13

ISO 9001

Planning

Ensuring that the quality system supports the business activities.

Planning of workload to ensure customers requirements are achieved.

Slide 14

ISO 9001

Responsibility

Management & supervision authority & responsibility documented & communicated.

ISO co-ordinator defined.

Internal communication – regular team briefings.

Slide 15

ISO 9001

Management Review

Review of the whole system by management:

- Follow up from previous management review meetings.
- Internal audit results.
- Customer feedback.
- Process performance & product conformity.
- Prevention & corrective actions.
- QMS changes.
- Recommendations for improvement.

Slide 16

ISO 9001

Provision of Resources

- Sufficient resources to implement the QMS & to continually improve its effectiveness.
- Enhance customer satisfaction by meeting customer requirements.

Slide 17

ISO 9001

Human Resources

Ensuring people are competent at what they do:

- Provide necessary training.
- Skills matrices.
- Ensure people are aware of the relevance & how their actions contribute to achieve quality objectives.
- Employee review & development.

Slide 18

ISO 9001

Infrastructure

Suitable:

- Buildings.
- Workspace.
- Associated utilities.
- Process equipment.
- Support services.

Slide 19

ISO 9001

Work Environment

Suitable conditions:

- Temperature.
- Humidity.
- Lighting.

Slide 20

ISO 9001

Product Realisation

Plan & develop processes for:

- Customer's requirements.
- Suitable resources for the product.
- Ensure product acceptance.
- Product acceptance records.

Slide 21

ISO 9001

Customer Related Processes

Contract Review

- All customer requirements specified.
- Statutory & regulatory requirements compliance.
- Review all requirements.
- Amendments implemented.
- Ability to meet requirements.

Slide 22

ISO 9001

Customer Communication

- Product information.
- Order handling.
- Contact information.

Slide 23

ISO 9001

Design Control

- Planning.
- Design input.
- Reviews.
- Verification – to ensure design has met design inputs (the spec).
- Validation – to ensure the design is capable of meeting requirements.
- Change.
- Output.
- Project Management

Slide 24

ISO 9001

Purchasing

- Conformance with specified customer requirements.
- Control of suppliers.
- Assessment of suppliers.
- Supplier monitoring.
- Purchase requirements.
- Adherence to purchase order requirements.

Slide 25

ISO 9001

Production & Service Provision

- Process monitoring, instructions, job / route cards, drawings & specifications.
- In-process & final inspection.
- Processes validated to ensure product conformance.
- Product identification & traceability.
- Control of customer owned property.
- Preventing damage / packing specifications.

Slide 26

ISO 9001

Control & Monitoring of Measuring Equipment

Calibration of measuring & process equipment for example:

- Digital verniers.
- Micrometers.
- Temperature meters.
- Gloss meters.

Slide 27

ISO 9001

Measurement, analysis & Improvement.

Using KPI data to improve the business.

- Customer satisfaction.
- Internal audits.
- Processes.
- Product.
- Non-conforming product.

Slide 28

ISO 9001

Improvement

- Continual improvement of business.
- Eliminate causes of nonconformities & apply suitable corrective action.
- Eliminate any potential future nonconformities.

Slide 29

ISO 9001

Thank you
for
your time.

Appendix 1g: ISO14001

Slide 1

ISO 14001

Hello
&
Welcome

Slide 2

ISO 14001

Origin of ISO 14001 EMS

The 1987 report for the world commission & develop called the Bruntland report stated that sustainable development is:

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs".

Slide 3

ISO 14001

Even before the Bruntland report — small groups of people protested about looking after our planet & they began to make a stand for example:

- Green Peace
- Greenham Common
- Eco-warriors
- The Green Party

Slide 4

ISO 14001

Benefits:

- Competitive Edge
- Compliance with Environmental Legislation
- Environmentally Friendly Business
- Cost Savings
- Lower Operating Costs
- Improved Method of Working
- Reduced Raw Materials
- Energy reduction

Slide 5

ISO 14001

What is ISO 14001?

ISO 14001 has been created by Scientists, Academics & Industry.

It is accepted across the world as a commitment to look after our planet.

Similar concept to ISO 9001 QMS - some of the requirements of ISO 14001 can be integrated into ISO 9001.

Slide 6

ISO 14001

Is ISO 14001 to do something with what I hear on the news - with regards to global warming?

Yes and:

- Green house effects.
- Acid rain.
- Ice caps melting.
- Glaciers falling.
- Climate changes.

•Extreme weather conditions around the world.

- claimed by the scientists as part of the life style of the modern world
- caused by not understanding the effects of the materials and chemicals we use to produce everyday.

Slide 7

ISO 14001

What are the main principles of ISO 14001 in our business?

When making product for our customers we start with:

Raw material (the input) & convert it into product (the output).

Therefore the main principle of ISO 14001 is to convert the input into the output - while minimising pollution to our planet.

It seeks to also minimise:

- Primary energy resources: Electricity / Gas / Water.
- Raw Material: Steel / Wood / Plastic.
- Packaging: Cardboard / Paper
- Emission reduction: Air / Land / Sewer

Slide 8

ISO 14001

Why should we have ISO 14001?

Customers are requesting that our business is certified to ISO 14001.

Provides a professional image.

It will ensure that the business operates within environmental law.

Demonstrates business commitment to the environment.

Slide 9

ISO 14001

What if we do not have ISO 14001?

Companies that do not take this approach:

- Could lead to further damage to our planet.
- Possibility of lost work to the competition, that have ISO 14001.
- Not complying with environmental law & face prosecution.
- Not make the potential savings available.

Slide 10

ISO 14001

So what is involved with ISO 14001?
Simple & effective procedures.

The requirements of ISO 14001 will prompt us to develop our business in terms of environmental compliance.

Objectives & targets to support Continuous Improvement.

Minimising our pollution to the environment.

Slide 11

ISO 14001

What is pollution?
Pollution comes in many forms:

- Emissions to the air.
- Releases to the water.
- Waste management.
- Land contamination.
- Raw material usage.
- Use of natural resources.

Slide 12

ISO 14001

ISO 14001 just another 'buzz-word'?

Not at all!

By designing the system to be simple & effective we can make real contribution to the planet and to also our business activities at the same time.

I think you would agree it is important that review & reduce any potential effects to the environment.

Slide 13

ISO 14001

Who enforces Environmental Legislation?
Environmental Legislation comes from the top:

- World leaders are informed by the top scientists of the effects.
- World environmental formats are agreed.
- In the case of the UK the laws are produced from Europe.
- The Environmental Agency liaise with local businesses to ensure businesses comply.

Slide 14

ISO 14001

How can we measure our success?

We shall look at areas we could improve & begin to measure them.

After improvements have been made we can show what we have saved as a result.

Slide 15

ISO 14001

Communication

This is paramount throughout the organisation to ensure we look at all of the issues - this presentation is the beginning.

The best ideas come from within people within the business closest to the processes.

By effective communication we should be able to establish some very interesting that could be of benefit.

Slide 16

ISO 14001

Smarter Solutions

Seeking improved ways & using less resource and reducing.

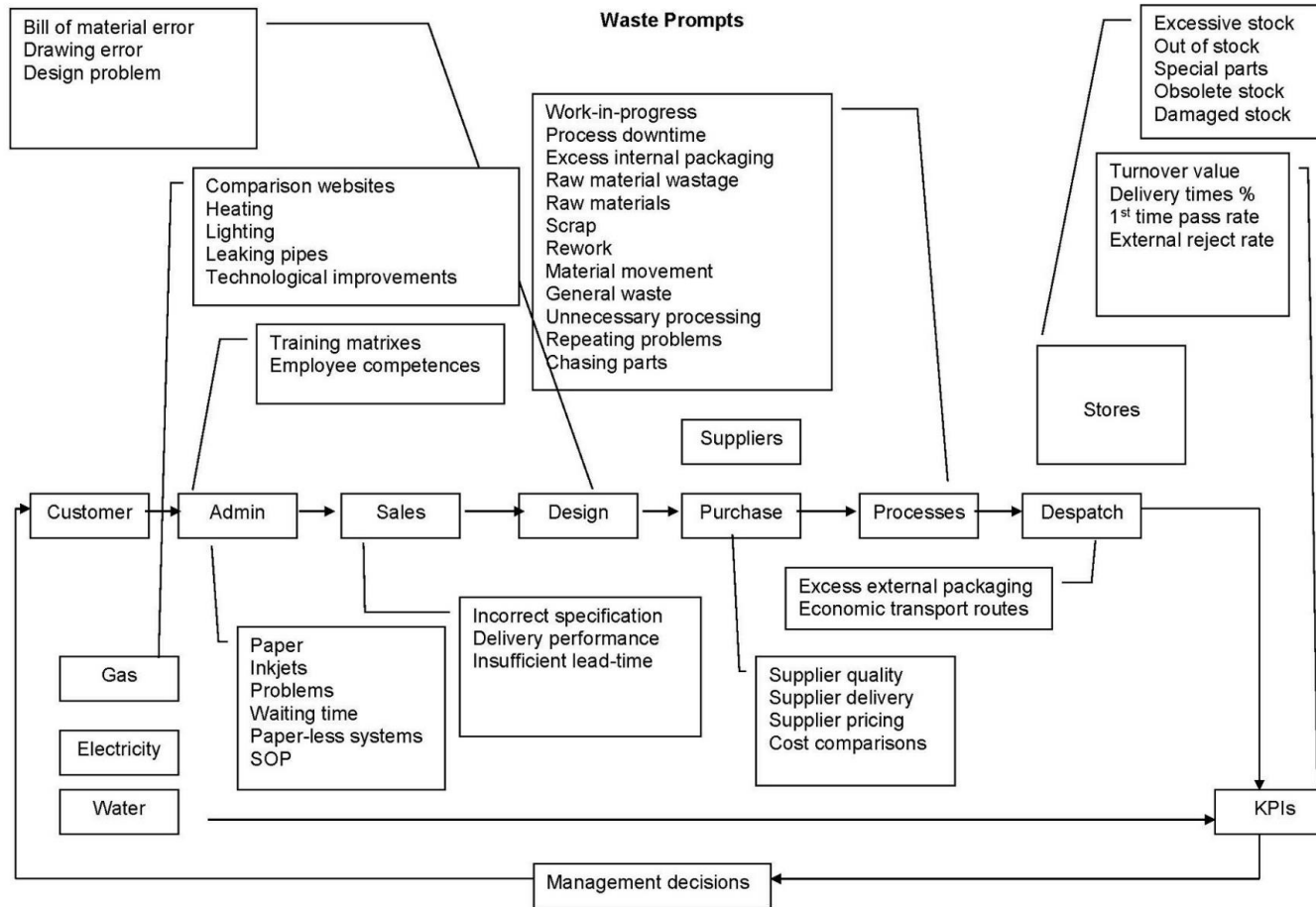
We made need to look at technology to help us make an impact and in certain areas of the business.

Slide 17

ISO 14001

Thank you
for
your time

Appendix 2: Waste Prompts



Appendix 3: KPI Sample Proposals

Sales

Turnover, Late delivery, Specification errors

Design

Bill of Material errors, Drawing errors

Purchasing

Quality, Delivery

Production

Process downtime, Quality defects, WIP levels, Bottlenecks, Progressing hours, Internal movement, Parts made not required

Quality

1st time pass rate, Internal problems, External problems

Despatch

Stock levels, Out of stock issues, Late deliveries

Resources

Gas, Electricity, Water, Raw materials, Packaging

Accounts

Credit notes

Appendix 4: Waste Identification Audit Sheet

Project Sheet

Origin of Problem: Meeting / Audit:

Place of audit: _____ Date: _____

Problem No: _____ Originator: _____

Description: _____ Part No: _____ Qty: _____

Detail: _____

CI techniques:

Histograms
Brainstorming
Five
Whys
Cause & effect

Required Action	Plan, Do Check	Who	When	Date act'd	Status

Cost Analysis	Reason	£
Time saved (hrs)		
Other savings		
Total saving		

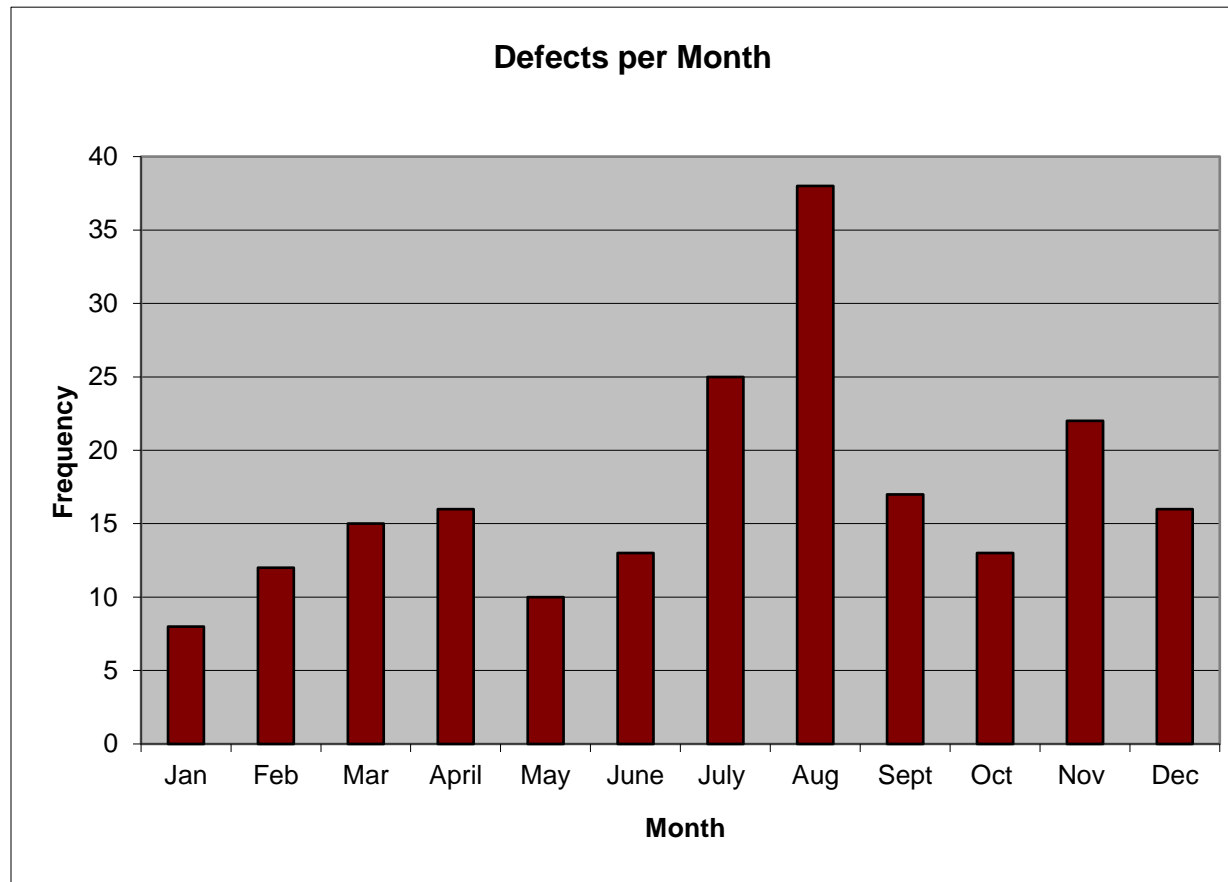
Project Closed / Date

Appendix 5: Sample Process KPIs Format

[illegible]

Appendix 6: Histogram Sample

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
8	12	15	16	10	13	25	38	17	13	22	16



Appendix 7: Brainstorming Sample

Problem:

Date: Team:

Generating ideas from a group meeting:

Appendix 8: Five Whys

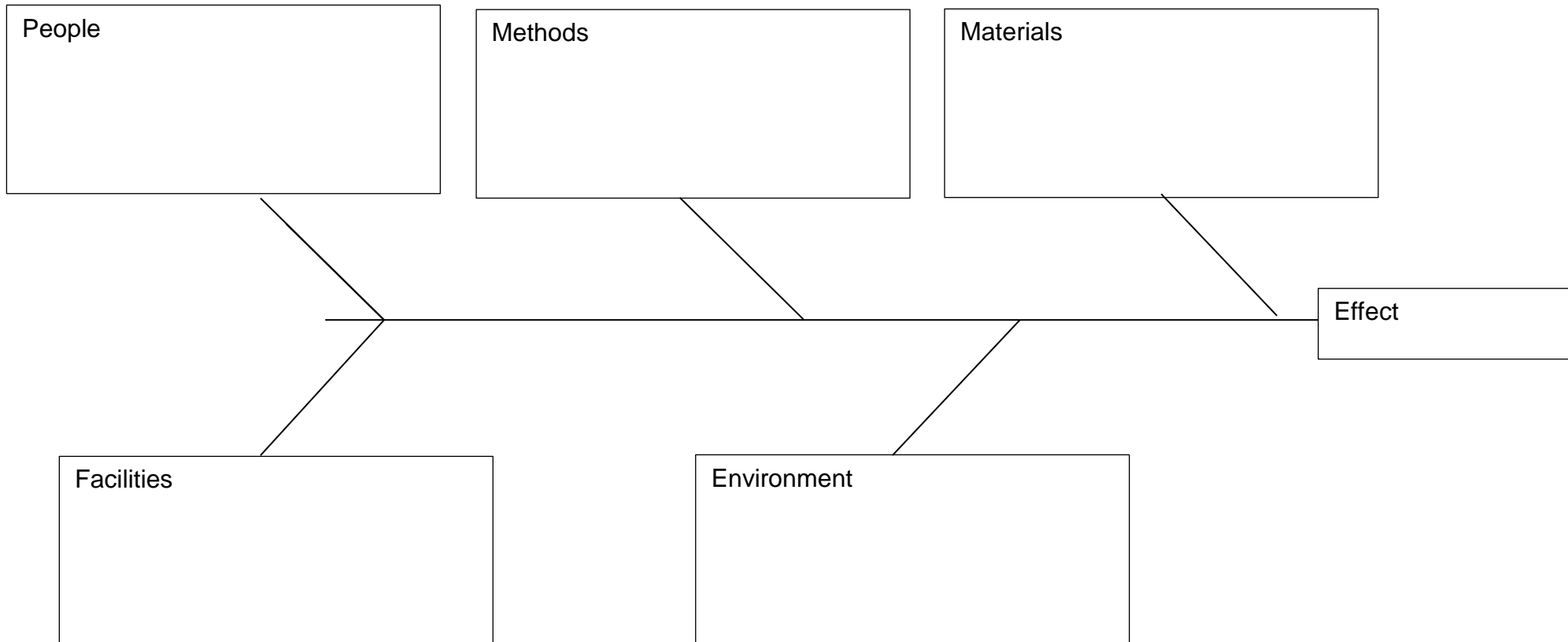
Problem:

Date:

Team:

Why	
Why	
Why	
Why	
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Why	
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Why	
Why	
Why	
Why	
Why	
Why	

Appendix 9: Cause and Effect



Appendix 10: Project Sheet

Project Sheet						CI techniques:			
Orgin of Problem: Meeting / Audit:						Histograms			
Place of audit: _____ Date: _____						Brainstormng			
Problem No: _____ Orginator: _____						5 Whys			
Description: _____ Part No: _____ Qty: _____						Cause & effect			
Detail: _____									
Required Action Plan, Do Check						Who	When	Date act'd	Status
Cost Analysis		Reason				£			
Time saved (hrs)									
Other savings									
Total saving								Project Closed / Date	

Appendix 11: Improvements Summary

1	Improvements Summary								
2									
3	Date	Part No	Description	Problem	Person Resp	Status	Closed	Saving £	
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29						Total Savings			
30									
31									
32									

Appendix 12: Pilot Study Questionnaire

All information will be strictly confidential

Company name: _____ Contact: _____ Position: _____ Date: _____
Address: _____
Post code: _____
Tel: _____ Fax: _____ Email: _____
Number of employees: _____ Products: _____

Please tick box / electronically press 4

1) Please rate your computer skills in the following software.

Word Good ☐ Average ☐ Poor ☐

Excel Good ☐ Average ☐ Poor ☐

Access Good ☐ Average ☐ Poor ☐

2) Has your business implemented any of the following standards?

TS 16949 (QS9000) Yes ☐ No ☐ Future ☐

ISO 9001 Yes ☐ No ☐ Future ☐

ISO 14001

Yes ☐

No ☐

Future

☐

Please list any other standards: _____

3) Do you use a business professional to implement any improvement techniques?

Yes ☐

No ☐

If Yes, please state:

Quality Engineer ☐

Quality Manager ☐

Consultant ☐

Other: _____

4) Please rate your knowledge of the following waste minimisation practices.

Overproduction Good ☐ Average ☐ Poor ☐

Waiting Good ☐ Average ☐ Poor ☐

Transport Good ☐ Average ☐ Poor ☐

Inappropriate processing Good ☐ Average ☐ Poor ☐

Unnecessary inventory Good ☐ Average ☐ Poor ☐

Unnecessary motion Good ☐ Average ☐ Poor ☐

Defects Good ☐ Average ☐ Poor ☐

5) Does your business use waste minimisation practices?

Typical examples:

Production downtime Yes ☐ No ☐

Quality first-time pass rate Yes ☐ No ☐

Others, please specify: _____

6) Is your business under pressure to improve efficiency? Yes ☐ No ☐

If Yes, please specify:

Shareholders wanting a return on investment Yes ☐ No ☐

Customers wanting a prompt low cost product Yes ☐ No ☐

Legislation Yes ☐ No ☐

Competition Yes ☐ No ☐

Technological innovation Yes ☐ No ☐

Others, please specify: _____

7) Please state if there are any barriers in your business that prevent waste minimisation initiatives.

Lack of waste minimisation goals	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Lack of resources	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Poor management commitment	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Poor technical knowledge of processes	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Production pressure	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Other, please specify: _____

8) Does your business use any of the following process improvement techniques?

Cause and effect charts

Use Frequently <input type="checkbox"/>	Use some times <input type="checkbox"/>	Aware but don't use <input type="checkbox"/>	Not familiar with technique <input type="checkbox"/>
-----------------------------------------	-----------------------------------------	----------------------------------------------	------------------------------------------------------

Pareto analysis

Use Frequently <input type="checkbox"/>	Use some times <input type="checkbox"/>	Aware but don't use <input type="checkbox"/>	Not familiar with technique <input type="checkbox"/>
-----------------------------------------	-----------------------------------------	----------------------------------------------	------------------------------------------------------

Brainstorming

Use Frequently <input type="checkbox"/>	Use some times <input type="checkbox"/>	Aware but don't use <input type="checkbox"/>	Not familiar with technique <input type="checkbox"/>
-----------------------------------------	-----------------------------------------	----------------------------------------------	------------------------------------------------------

Tally charts

Use Frequently <input type="checkbox"/>	Use some times <input type="checkbox"/>	Aware but don't use <input type="checkbox"/>	Not familiar with technique <input type="checkbox"/>
-----------------------------------------	-----------------------------------------	----------------------------------------------	------------------------------------------------------

Five

Whys

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

KPIs

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Value Analysis / Value Engineering

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Kaizen

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

9) Please list any other improvement techniques or methods used: _____

10) If you have used any improvement techniques briefly describe your experiences: _____

11) Please state what could be done differently to help support your business use improvement techniques:

12) Please list any reasons for not using any improvement techniques:_____

13) Would you be interested if you were guided on the relevant sources of business improvement techniques?

14) Please list typical benefits to your business that would occur if you were to use improvement techniques,
please refer to question 4:

1:_____

2:_____

3:_____

15) Would your business be interested in joining in our research network?

Yes ☐ No ☐

16) May I contact you by either email or telephone at a later date if required?

Yes ☐ No ☐

17) Please inform us in the space below of any ideas of a suitable process model concept.

Thank you for taking the time to complete our questionnaire.

Paul Smith

email pgs@sky.com

Fax 01384 74936

Appendix 13: Structured Interview

*All information will be strictly
confidential*

Company name: _____ Contact: _____ Position: _____ Date: _____
Address: _____
Tel: _____ Fax: _____ Post code: _____
Number of employees: _____ Products: _____ Email: _____

Please feel free to comment on any of the questions.

Please tick box / electronically press 4

Please rate your computer skills in the following software.

Word	Good	<input type="checkbox"/>	Average	<input type="checkbox"/>	Poor	<input type="checkbox"/>
Excel	Good	<input type="checkbox"/>	Average	<input type="checkbox"/>	Poor	<input type="checkbox"/>
Access	Good	<input type="checkbox"/>	Average	<input type="checkbox"/>	Poor	<input type="checkbox"/>

Has your business implemented any of the following process models?

<i>TS 16949 (QS9000)</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>ISO 9001</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>ISO 14001</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>Plan - Do - Check - Action</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>Business Excellence Model</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>Knowledge based Systems</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>
<i>Balanced Score Cards</i>	Yes	<input type="checkbox"/>	No	<input type="text"/>	Future	<input type="checkbox"/>

Please list any other process models: _____

Please inform of the strengths of any process models you have implemented.

Please inform of the weaknesses of any process models you have implemented.

Would top management fully support any business improvement or waste minimisation project?

Yes ☐ No ☐

If no please inform of the reasons why not: _____

Is your business under pressure to improve efficiency?

Yes ☐ No ☐

If Yes, please specify:

Current economic climate

Yes

☐

No

☐

Shareholders wanting a return on investment

Yes

☐

No

☐

Customers wanting a prompt low cost product

Yes

☐

No

☐

Legislation

Yes

☐

No

☐

Competition

Yes

☐

No

☐

Technological innovation

Yes

☐

No

☐

Others, please specify: _____

Do you use a business professional to implement any improvement techniques?

Yes

☐

No

☐

If Yes, please state:

Quality Engineer

☐

Quality
Manager

☐

Consultant

☐

Other: _____

If you have used any improvement techniques briefly describe your experiences: _____

Have any of your courses that you have attended had any content of the use & benefits of CI techniques?

Yes ☐ No ☐

Comments: _____

Please list any business measures (KPIs that have been implemented.

1

2

3

4

5

6

7

8

9

Is there any person in the organisation who has knowledge & experience of CI techniques?

Yes ☐ No ☐

Comments: _____

If you had a business problem to solve, please inform me how you would structure your approach.

Please inform me what your perception of waste minimisation is: _____

Please inform me what your perception of business improvement is: _____

Please inform me how you would reduce business waste.

Please inform me how you would improve business performance?

Please rate your knowledge of the following waste minimisation practices.

Overproduction	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>
Waiting	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>

Transport	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>
Inappropriate processing	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>
Unnecessary inventory	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>
Unnecessary motion	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>
Defects	Good	<input type="checkbox"/>	Average	<input type="text"/>	Poor	<input type="checkbox"/>

Please inform me what you think the definition of Continuous Improvement techniques means to you.

Does your business use waste minimisation practices?

Typical examples:

Production downtime	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Quality first-time pass rate	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Administration	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>

Others, please specify: _____

Please state if there are any barriers in your business that prevent waste minimisation initiatives.

No business improvement strategy	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of waste minimisation goals	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
No business waste measures	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Fear of change	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor top management commitment	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor middle management commitment	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor supervision commitment	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor worker commitment	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor technical knowledge of processes	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Production pressure	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Bureaucratic obstacles	Yes	<input type="checkbox"/>	No <input type="checkbox"/>

Lack of communication	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Not sure what to do	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Poor problem definition	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of human resources	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of financial resources	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Already stretched resources	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Cutbacks	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
One one person responsible	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of waste minimisation knowledge	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of process understanding	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Bureaucracy	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Over complicated improvement programme	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of motivation	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Too many previous failed projects	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Lack of CI knowledge	Yes	<input type="checkbox"/>	No <input type="checkbox"/>

No simple CI tool available	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Accepted bad practices	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Business culture	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Negative approach	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Business inflexible	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
No incentive system	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
No employee development programmes	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Unaware where to seek additional information	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
CI techniques not required by customer	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Too busy with day - to - day activities	Yes	<input type="checkbox"/>	No <input type="checkbox"/>
Too many problems to deal with	Yes	<input type="checkbox"/>	No <input type="checkbox"/>

Other, please specify: _____

Does your business use any of the following process improvement techniques?

Cause and effect charts

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Pareto analysis

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Brainstorming

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Tally charts

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Five Whys

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

KPIs

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Value Analysis / Value Engineering

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Kaizen

Use Frequently ☐ Use some times ☐ Aware but don't use ☐ Not familiar with technique ☐

Please list any other improvement techniques or methods used: _____

Please state what could be done differently to help support your business use improvement techniques:

*Please list any reasons for not using any improvement techniques:*_____

Would you be interested if you were guided on the relevant sources of business improvement techniques?

Yes ☐ No ☐

*Comments:*_____

Please list typical benefits to your business that would occur if you were to use improvement techniques.

1: _____

2: _____

3: _____

Has Business Link, Advantage or The Society of Motor Manufacturers & Traders or any other agency contacted you about any business improvement initiatives?

Yes

☐

No

☐

Comments: _____

Do you know of any other businesses that use CI techniques for waste minimisation?

Yes ☐ No ☐

Would you be interested in learning more about CI techniques?

Yes ☐ No ☐

Comments: _____

Are you aware of any academic publications: research papers & Journals on CI techniques?

Yes ☐ No ☐

Comments: _____

Are you aware of any books on CI techniques?

Yes ☐ No ☐

Comments: _____

Are you aware what CI techniques are available on the Internet?

Yes ☐ No ☐

Comments: _____

Has your business been involved with any improvement projects?

Yes ☐ No ☐

Comments: _____

Do your customers support any CI improvement initiatives?

Yes ☐ No ☐

Comments: _____

Do any of your suppliers use CI techniques?

Yes

No

☐

Comments: _____

If there was a simple approach would you be interesting in reducing business waste & improving business performance?

Comments: _____

Why do you think that many businesses do not use CI techniques?

Comments: _____

Do you think people appreciate the importance and significance of using CI techniques?

Yes ☐ No ☐

Comments: _____

Do you feel people are confident in using CI techniques?

Yes ☐ No ☐

Comments: _____

Do you have any contact with Universities or Colleges?

Yes ☐ No ☐

Comments: _____

What could Universities do differently to get businesses to use CI techniques?

Could CI tools could be made eaiser.

Yes

☐

No

☐

Comments: _____

Why do you think CI techniques are not often used in businesses?

Why do you think that some customers insist that their suppliers use CI techniques?

Please inform us in the space below of any ideas of a suitable process model concept.

Thank you for taking the time for this structured interview.

Paul Smith email Fax 01384 74936
 pgs@sky.com